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DISEASES AND INJURIES
OF
THE EYE

SIXTH EDITION.



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DISEASES AND INJURIES OF THE EYE

WITH

THEIR MEDICAL AND SURGICAL TREATMENT.

BY

GEORGE LAWSON, F.R.C.S.ENG.,

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MEMBER OF THE COUNCIL OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND;
CONSULTING SURGEON TO THE ROYAL LONDON OPHTHALMIC HOSPITAL
AND TO THE MIDDLESEX HOSPITAL.

Sixth Edition, with 249 Illustrations.

REVISED AND IN GREAT MEASURE RE-WRITTEN

BY

ARNOLD LAWSON, F.R.C.S.ENG.,

ASSISTANT SURGEON TO THE ROYAL LONDON OPHTHALMIC HOSPITAL;
OPHTHALMIC SURGEON TO THE PADDINGTON GREEN CHILDREN'S HOSPITAL;
CONSULTING OPHTHALMIC SURGEON TO THE ROYAL HOSPITAL FOR INCURABLES, PUTNEY,
AND TO THE HOSPITAL OF ST. JOHN AND ST. ELIZABETH, ST. JOHN'S WOOD.

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PREFACE TO THE SIXTH EDITION.

THOSE who remember the last edition of this work, which was published in 1885, will scarcely recognise it in its new dress. The great success that attended former editions decided me to make an attempt to place it once more on a sound basis.

Much care and labour has been taken to make the work as practical as possible. It was chiefly owing to the attention paid to the clinical features, and to the treatment of the various eye diseases, that the book obtained its former popularity; and to these portions, and especially to treatment, a much larger space has been allotted than is usually the case. At the same time, much more attention has been paid to the anatomical, pathological, and theoretical aspects, and, as a consequence, and owing partly to the great strides made of late years in ophthalmic surgery, the book has greatly increased in size.

My endeavour has been, briefly, to present a work which will serve not only for the student of ophthalmology, but will also prove useful as a book of reference for the general practitioner, who is more concerned with the practical relief of disease than with the theory of it. I can only hope that, in some measure at least, this attempt has been successful, and if so, the labour which has occupied the greater part of the leisure time of three years will be amply rewarded.

Several new features have been introduced. The book has been divided up into chapters, which it was thought would conduce to clearness and simplicity, and the chapter on each structure is headed by a brief anatomical outline, which may facilitate study of the diseases of that particular structure. Entirely fresh articles on "Elementary Optics," "Development of the Eye," "The Pupil," "Affections of the Eye in Diseases of the Nervous System," "Heterophoria," and a brief

Appendix, have been added. All the other parts of the work have been very carefully revised, re-written, and much new material added.

The Index has received very special attention. It has been planned on a much more elaborate scale than is usual in medical works, and though it has necessarily occupied much room, yet the increased facilities for reference thus afforded will, I trust, prove its justification.

One hundred and fifty new illustrations have been inserted, most of them, including all the illustrations of the fundus but one, being painted by Miss M. H. Brooks, of 5, Marriott Road, Barnet, to whom my best thanks are due, as they are also to Mr. F. Butterworth, of 115, Strand, who undertook the engraving.

To Dr. J. Risien Russell, F.R.C.P., and to Mr. J. Herbert Parsons, F.R.C.S., who afforded me much kindly help in different parts of the work, I desire to express my most cordial thanks. I am further greatly indebted to Mr. Reginald E. Bickerton, F.R.C.S., who, at the cost of much labour, has helped me to revise the proofs, and in doing so contributed many valuable suggestions, which are incorporated in the work.

ARNOLD LAWSON.

12, HARLEY STREET, W.

March, 1903.

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DISEASES OF THE EYE.

CHAPTER I.

ELEMENTARY OPTICS.

A CERTAIN knowledge of the laws that govern the refraction and reflection of light is essential in ophthalmology. In the following section an endeavour is made to present these fundamental principles in a simple manner that can be easily grasped by a reader who has had no previous optical training.

Light Paths.—Light from a luminous object radiates in all directions in straight lines which are termed *rays*. These rays are at first divergent, but after proceeding for about 20 feet their divergence is so slight as to be negligible in practice, and it is customary to speak of light rays as becoming parallel. A collection of rays diverging from, or converging to a point is called a *pencil* of rays, and the point of their intersection is termed a *focus*.

When rays of light impinge on a medium of different density a certain number are cast back or *reflected* into the first medium, whilst others are transmitted or *refracted* into the second medium.

GENERAL LAWS OF REFRACTION AND LENSES.

When rays of light pass through into a new medium they become bent or refracted. If the medium has parallel faces the rays, though displaced, will pursue on emergence a direction parallel to that which they had on entering it.

Thus if (A B) (Fig. 1) be a ray of light passing into a denser medium (M) its course on emergence will be represented by (C D), whilst (A B C') will represent the course of such a ray had no refraction taken place.

It will be seen that the bending takes place both at (B), on entering, and at (C), on leaving the medium, and that it is towards the perpendicular on passing into a denser medium, such as (M), and away from the perpendicular on emergence into a less dense medium. The greater the difference between the densities of the contiguous media the greater the refraction, and *vice versa*. The amount of deflection that takes place is expressed as the *refractive index* of the medium, the unit or standard being the deviation of light passing from vacuum into air.

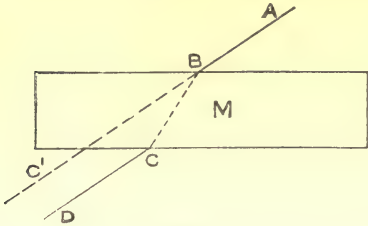


FIG. 1.

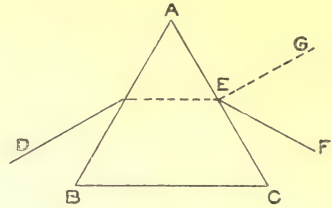


FIG. 2.

If the surfaces of the medium are not parallel, but approximate each other as in a *prism* (A B C) (Fig. 2), then rays of light such as (D) do not emerge parallel to their original direction such as (E G), but are bent towards the thick part or base, as (E F).

LENSES.

A lens is a transparent medium with one or both surfaces curved. Its power of refraction depends not only upon its density but upon the curvature of its surfaces.

Lenses may be divided into two main classes :

1. Spherical lenses.
2. Cylindrical lenses.

1. A **Spherical Lens** may be analysed as consisting of a double set of prisms, arranged either base to base, in which case it is called a *convex lens*, or apex to apex, when it is known as a *concave lens*.

Several modifications of convex and concave lenses exist, as (A, B, C,

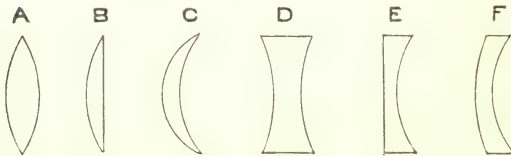


FIG. 3.

D, E, F) (Fig. 3), but in each case the lens is governed by a common series of laws which affect the group to which it belongs.

The convex group comprises (A) the *biconvex*, (B) the *plano-convex*, and (C) the *concavo-convex* or *meniscus*, in which the convex curve is higher than the concave. The concave group includes (D) the *biconcave*, (E) the *plano-concave*, and (F) the *convexo-concave* or *standard lens*, in which the concave curve is higher than the convex.

Of these, the most important in each group, as being that in most general use, is (A) the biconvex and (D) the biconcave lens, and a short description of these varieties will suffice for all other modifications of convex and concave lenses respectively.

2. **Cylindrical Lenses.**—These have received their name because they may be defined as segments cut in the long axis of a solid cylinder (see Fig. 4). They thus present a plane surface on one side (A A A), and

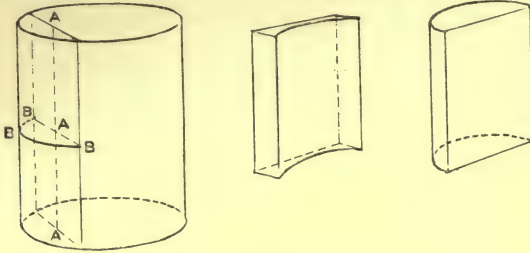


FIG. 4.

on the other are curved in only one meridian, viz. that which is transverse to their long axis (B B B). It is plain that a segment of this kind may be cut so as to present a convex or a concave curve, and cylindrical lenses are therefore divided into (1) *convex* cylinders, and (2) *concave* cylinders.

General Laws governing all Lenses.

The line joining the centre of curvature of each surface is known as the *principal axis* of the lens. A ray of light passing along the principal axis is not refracted, and is known as a *primary ray*.

The *optical centre* or *centre* of the lens is a point on the principal axis. Rays of light passing through the centre are termed *secondary rays*, and their paths *secondary axes*. It is customary to disregard the slight deflection of secondary rays, and to consider them as passing through the lens unrefracted.

Parallel rays of light after passing through the lens are brought to a focus at a spot known as the *principal focus* of the lens, and the distance of this point from the lens is called the *focal distance*.

The strength of the lens is gauged by its focal distance, and the greater the curvature of the lens surface the shorter is the focal distance, and the more powerful is the lens.

Rays emanating from an object nearer to the lens than twenty feet are still divergent on reaching the lens, and will meet at a point known as a *secondary focus*. The nearer the object approaches to the lens the more divergent are the rays, and, therefore, every lens possesses an infinite number of secondary foci.

An *image* is a collection of foci corresponding to a luminous object. It may be erect or inverted, real or virtual. The image is said to be *real* when it is formed as the natural intersection of the refracted and non-refracted rays after passing through the lens; and it is called a

virtual image when it is formed by tracing these rays backwards to points of intersection on the same side of the lens as the luminous object.

In the following remarks the complications involved by the thickness of the lens are for the sake of clearness and simplicity disregarded, and it will be sufficient to explain the laws of refraction as applied to what are known as *thin lenses*.

Biconvex Lenses and their Images.

The analysis of a biconvex lens into two prisms placed base to base is shown in Fig. 5. As rays of light in passing through a prism become deflected towards its base (*vide supra*), it is evident that parallel

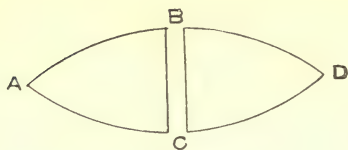


FIG. 5.

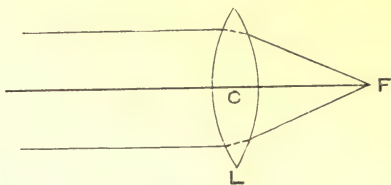


FIG. 6.

rays of light after passing through a biconvex lens will *converge* towards each other and will meet at (F) (Fig. 6), which is therefore the principal focus of the lens (L). Conversely, rays proceeding from a luminous point (F), situated at the principal focus, will not meet in a focus, but

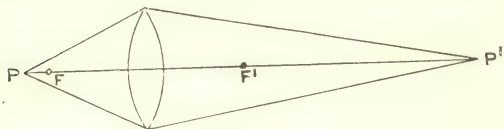


FIG. 7.

will proceed as parallel rays after passing through the lens. Rays proceeding from an object nearer than twenty feet will still be divergent on reaching the lens, but will be brought to a focus on the other side of the lens at some point further off than the principal focus, provided that they do not emanate from an object situated nearer to the lens than the principal focus.

Thus, in Fig. 7, where (F) and (F') represent the principal foci, rays

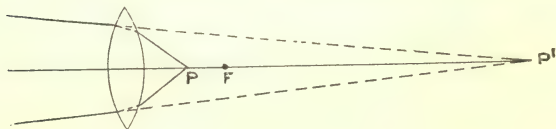


FIG. 8.

proceeding from an object at (P) will have their focus at (P'), and conversely rays emanating from (P') will be focussed at (P). Thus (P) and (P') are images of each other, and are spoken of as *conjugate foci*. If the luminous object is placed nearer to the lens than the principal focus, as (P) in Fig. 8, *i. e.* within the focal distance, the rays, after passing through the lens, will be still divergent, though less so, and cannot consequently be

brought to a real focus on the other side. If, however, they are prolonged backwards they will appear to meet at (P'), where a virtual focus of (P) will be formed.

Images formed by a Convex Lens.—These will now be readily understood.

1. *The image is real and inverted, provided that the object is at a greater distance than the principal focus.* In Fig. 9, if (AB) be the object, parallel rays drawn from (A) and (B) to the lens (L) will intersect at the principal focus. Rays (AC) and (BC) drawn through (C), the centre of the lens, will be unrefracted. Then (B') being the point where rays from (A) will intersect, and (A') being the point where rays from (B) will meet, it follows that ($B'A'$) will represent the image of (AB).

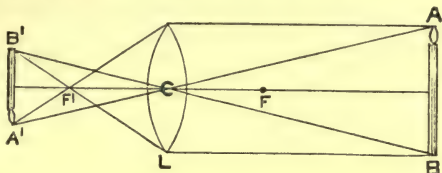


FIG. 9.

Conversely, if ($B'A'$) be the luminous object it will have its image at (AB). Therefore ($B'A'$) and (AB), being images of each other, are *conjugate images*. In tracing the image from ($B'A'$) the course of parallel rays has been purposely omitted from Fig. 9 to show that the image can be constructed by tracing the intersection of any refracted rays with the non-refracted rays that pass through the centre of the lens.

2. *The image will also be smaller than the object, provided that it is situated further from the lens than twice the focal distance ($2F$).* In Fig. 9, as (AB) approaches the lens the further does its image ($B'A'$) recede from it, and the larger does it become, so that—

3. When (AB) is situated at ($2F$) its image will be placed at a corresponding point ($2F$) on the other side, and, though still inverted, will be of the same size as the object.

4. *The image is real, inverted, and larger than the object* when the latter is placed between (F) and ($2F$). In Fig. 9 ($B'A'$) is placed between (F) and ($2F$), and it has already been shown that (AB) will be the image of ($B'A'$), and (AB) is seen to be inverted and larger than ($B'A'$).

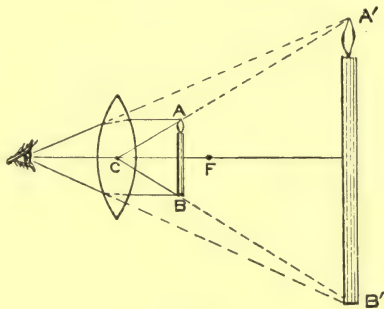


FIG. 10.

5. *The image will be virtual, upright, and larger than the object, provided that the object is situated nearer to the lens than the focal distance.* If (AB) (Fig. 10) the object be placed nearer to the lens than (F) the principal focus, then the rays, after passing through the periphery of the lens, will be still divergent and will appear to the observer's eye as emanating from ($A'B'$), where a virtual image will be formed at the points where the refracted and non-refracted rays meet if prolonged backwards. It is upon this latter property that the magnifying power of a convex lens depends.

It will be seen that the nearer (A B) is to the lens the smaller is its actual image (A' B'), and conversely, the nearer (A B) is to the principal focus the larger is (A' B'); so that (A' B') reaches its greatest dimensions when (A B) is situated just within the principal focus (F).

Biconcave Lenses and their Images.

An analysis of a biconcave lens as consisting of two prisms placed apex to apex is shown in Fig. 11. As rays of light in passing through a prism are deflected towards its base, so rays of light in passing through a biconcave lens are rendered divergent. It will be obvious that if parallel rays are made divergent, they cannot be brought to a real focus on the other side of the lens.

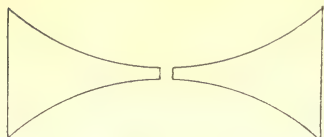


FIG. 11.

They will, however, if prolonged backwards, meet at a *virtual focus* on the same side of the lens as the luminous object, and this point will be the *principal focus* of the lens.

Thus, if (A, B, C, D, E) represent parallel rays of light (Fig. 12) and (a, b, c, d, e) their course after emergence from the lens; then (F) will

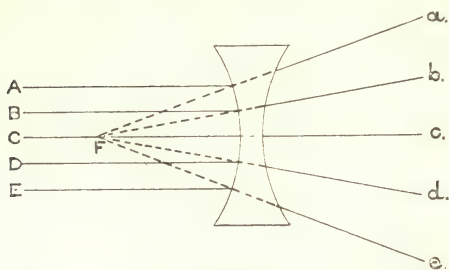


FIG. 12.

represent the principal focus of the lens. Divergent rays impinging on a biconcave lens, being rendered more divergent, will be brought to a virtual focus at some point nearer to the lens than the principal focus.

It follows that all the foci of a biconcave lens are virtual, and are formed at or nearer to the lens than the principal focus.

Images formed by biconcave lenses.—Just as all the foci of biconcave lenses are virtual, so all their images must be virtual. They are also

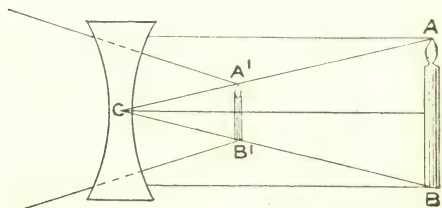


FIG. 13.

always erect and smaller than the object. If (A B) (Fig. 13) represent a luminous object, then parallel rays from (A) and (B) will, after passing through the lens, be rendered divergent, and if traced backwards will intersect the non-refracted rays passing through (C) the centre of the lens at (A' B'), which will therefore represent a virtual image of (A B). It will be evident by the same manner of construction that if (A B) be brought nearer to the lens, its image (A' B') will also approach the lens, and will gradually increase in size though always remaining smaller than (A B).

Cylindrical Lenses.

The peculiar conformation of a cylindrical lens has already been mentioned on page 3. Optically it possesses the property of allowing light rays which impinge upon its long axis, which is a plane surface on both sides of the lens, to pass through the lens without refraction (A A A) (Fig. 4). Rays which fall perpendicular to the long axis, *i. e.* along the curved surface of the lens (B B B) (Fig. 4), are refracted normally. As regards these latter rays, cylindrical lenses follow the same laws that govern convex and concave spherical lenses. Rays intermediate in direction between the two perpendiculars are refracted to a varying degree depending upon their angles of incidence. Cylindrical lenses are chiefly used for the correction of astigmatism.

GENERAL LAWS OF REFLECTION AND MIRRORS.

A ray of light (A I) (Fig. 14) falling on a reflecting surface (M M) is known as an *incident ray*, and the angle (A I P) which it makes with the perpendicular (P I), let drop to the point of incidence, is known as the *angle of incidence*. The ray (B I) which is thrown back or reflected from the surface is termed the *reflected ray*, and its angle with the perpendicular (P I) is called the *angle of reflection*.

The two great laws that govern the reflection of light are—

1. That the angle of incidence is equal to the angle of reflection.

2. That the angles of incidence and reflection lie in the same plane and on opposite sides of the perpendicular to the mirror.

It is obvious that if the incident ray lies perpendicular to the surface, its reflection must take place along the same path, and that in this case the incident and reflected ray will be identical.

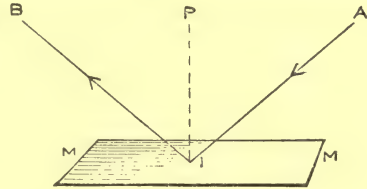


FIG. 14.

MIRRORS.

The total effect of reflection will be modified according as we are dealing with a plane or a curved surface. Mirrors are, therefore, divided into (1) *plane*, (2) *concave*, and (3) *convex* mirrors.

The images formed by mirrors may be upright or inverted, real or virtual. A real image is one that is formed on the same side of the mirror as the luminous object in the natural progress of the reflected rays. A virtual image is one that is constructed by tracing back the reflected rays to a focus on the opposite side of the mirror.

Plane Mirrors and their Images.—(A B) (Fig. 15) is a luminous object from which (A C) and (B D), pencils of light, impinge on the mirror (M M). According to the above-mentioned laws, these rays are reflected along angles equal to those of their incidence, and cannot, therefore, be

brought to a real focus, but will pass into the observer's eye, and appear to him to spring from a virtual image ($A'B'$) placed as far behind the mirror as (AB) is in front of it. It will be seen that ($A'B'$) is erect, and of the same size as (AB).

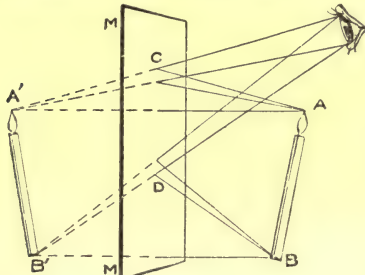


FIG. 15.

(B'), and therefore these latter points must represent the image of (A) and (B).

Images formed by plane mirrors are, therefore, in every case virtual, upright, of the same size as the object, and placed at the same distance behind the mirror as the luminous object is in front of it.

Spherical Mirrors.—A curved mirror may be considered to consist of a series of intersecting planes comprising part of a regular polygonal figure, and therefore the formation of images is more complicated than when dealing with a simple plane.

The centre of the sphere, of which the mirror is a component part, is called the *centre of curvature* of the mirror, and a line drawn through the centre of curvature to the vertex of the mirror is called the *principal axis*. It is evident that any line drawn through the centre of curvature to the mirror, being a radius of a circle, becomes the perpendicular to the plane of that portion of the mirror which it intersects, and therefore any ray that passes through the centre of curvature is reflected back along the same path.

Parallel rays of light are directed towards a point known as the *principal focus*, which is situated on the principal axis, halfway between the centre of curvature and the vertex of the mirror.

In a concave mirror, therefore, the centre of curvature being in front of the mirror, the general effect of reflection is to *converge* light rays to a *real focus*; and in

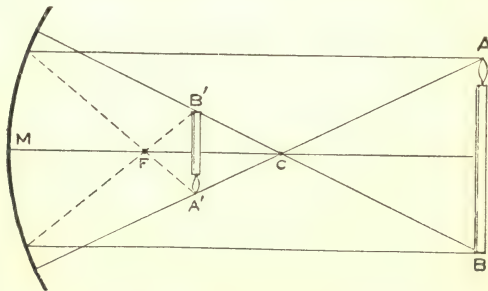


FIG. 16.

curvature.—This is simple. If (AB) (Fig. 16) represent the object, (C) the centre of curvature, and (M) the mirror, then parallel rays drawn

Geometrically, the construction of the image may be made by drawing perpendiculars from the extremities of the object to the mirror, and producing them to corresponding points on the other side, as (AA') and (BB'). It can be easily shown that any reflected rays from (A) and (B) will, if traced backwards, meet respectively at (A') and

in convex mirrors, in which the centre of curvature lies behind the reflecting surface, to cause *divergence* of rays, so that they appear to spring from a *virtual focus* behind the mirror.

Images formed by Concave Mirrors.—I. When the object is situated at a greater distance than the centre of

from (A) and (B) to the mirror must, after reflection, pass through (F), the principal focus. Rays from (A) and (B) that pass through (C) are reflected back along the same path, and the image of (A B) will therefore be at the spot (B' A') where the reflected rays produced through (F) intersect those passing through (C).

In this case, therefore, the image (B' A') is *real, inverted*, and *smaller* than the object, and is situated somewhere between the principal focus and the centre of curvature.

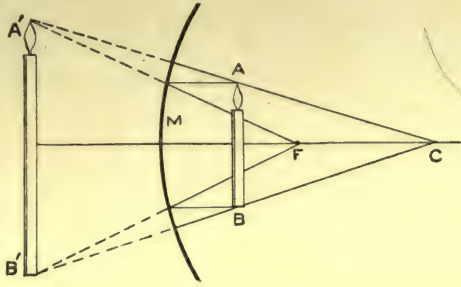


FIG. 17.

As the object is approximated to the mirror the image increases in size and recedes from it, so that—

2. When the object is situated at the centre of curvature, the image is inverted, of the same size as the object, and situated also at the centre.

3. When the object is placed between the centre of curvature and the principal focus, the image, though still inverted, is *larger* than the object, and is placed at a greater distance than the centre.

Thus it will be understood that if, in Fig. 16, the paths of light were reversed, a luminous object placed at (B' A') would have its image at (A B), and (A B) and (B' A') are therefore called *conjugate foci*.

4. When the luminous object is placed nearer to the mirror than the principal focus, as in Fig. 17. Following the same method of construction, it will be seen that rays of light drawn through (C) will not intersect those reflected through (F) unless traced backwards behind the mirror (M). Thus in this case the image (A' B') is *virtual, erect*, and *larger* than the object.

From the above it will be seen that concave mirrors deflect light rays in a similar way to convex lenses.

Images formed by Convex Mirrors.—These will be easily understood from what has already been stated in speaking of the general principles governing spherical mirrors.

It will be seen (Fig. 18) that (C), the centre of curvature, and (F), the principal focus, must always be virtual. If (A B) represents a luminous object, and parallel rays are drawn from (A) and (B) to the convex mirror (M), they will be rendered divergent so as to appear to come from (F), situated behind the mirror. If other rays from (A) and (B) be prolonged so as to pass through (C), the centre, then these rays will

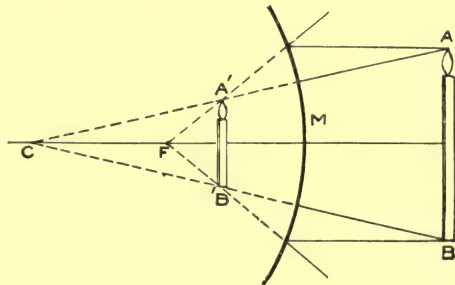


FIG. 18.

intersect with the first-named at ($A' B'$), which will therefore be the image of ($A B$).

It will be evident that the images formed by a convex mirror are always *virtual*, *erect*, and *smaller* than the object, and that they must always lie somewhere between the centre of curvature and the mirror.

It is also plain that convex mirrors deflect light rays in a similar manner to concave lenses.

CHAPTER II.

GENERAL PRINCIPLES OF OCULAR REFRACTION.

THE eye consists in the main of a series of refracting media designed to focus rays of light upon a percipient screen—the retina,—from which undue reflection is limited by a layer of black pigment known as the choroid.

These refracting media are four in number, and consist of two powerful convex lenses—the cornea and the crystalline lens,—which are bathed by two liquid media—the aqueous and vitreous humours. Whilst the crystalline lens has a greater refracting power than the cornea, the greatest deflection of light rays takes place at the anterior surface of the latter, because it is placed between the external air and the aqueous, between which two media there is a greater difference in density than between any two contiguous media in the eye. The convergence of light rays thus initiated at the cornea, and increased by the crystalline lens, is maintained by means of the aqueous and vitreous humours, which have a refractive index slightly greater than water, and so greater than the external atmosphere.

Ocular refraction is not, however, a constant and unalterable condition. Were that so, a clear image would be formed on the retina only when the luminous object was situated at the particular distance for which the refraction was adapted. In all other cases the focus of the rays would fall either in front or behind the retina, and the latter would only receive diffusion circles, which would produce a blurred instead of a clear image. The refraction of the cornea, aqueous, and vitreous is unchangeable, but that of the lens is constantly shifting by virtue of the *accommodation* (see page 14), so that the eye may be at once adapted for any object upon which the gaze is fixed.

Thus the eye possesses a certain **static** refraction, which is its refraction at rest, and, in addition, a **dynamic** refraction, which is the increased refractive power conferred by *accommodation*. The static refraction of the normal eye is such that parallel rays (A B) (Fig. 19), or those proceeding from a distance of twenty feet or more, are focussed on the retina (F), and an eye exhibiting this property is said to be in a condition of **emmetropia**. Abnormal conditions of static refraction, collectively known as **ametropia**, are exhibited when the antero-

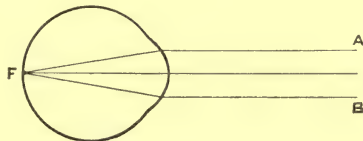


FIG. 19.—Emmetropia.

posterior diameter of the eye is too short or too long, so that the focus of parallel rays falls elsewhere than upon the retina. When the focal length of the eye is too short, so that the clear image would be formed somewhere behind the retina (Fig. 20), the eye is said to be in a

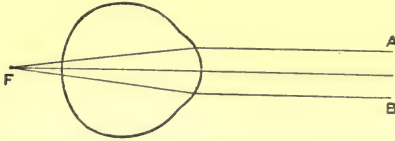


FIG. 20.—Hypermetropia.

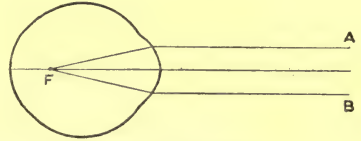


FIG. 21.—Myopia.

condition of **hypermetropia**; and when it is too long, so that parallel rays are focussed in front of the retina, **myopia** is said to be present (Fig. 21).

The Retinal Image.—The formation of the retinal image is easily understood by applying the principles of a convex lens already enumerated. The principal axis becomes the **optic axis** (O A) (Fig. 23), and is the straight line passing through the nodal point (N) (Fig. 23) and the centre of rotation (R) (Fig. 23) to the posterior pole, which is situated just to the outer side of the optic nerve. The optical centre is known as the **nodal point** (N) (Fig. 22), and it is situated on the optic axis 15 mm. from the retina and 7 mm. behind the cornea. Rays of light directed to this point pass through without deflection, so that to schematically form the retinal image it is only necessary to draw lines (B B', C C') (Fig. 22) through the terminal points of the luminous object, so as to pass through the nodal point to the retina.

Projection of the Retinal Image.—It will be evident that the retinal image so constructed will not only be smaller than the luminous object and inverted, but its position on the retina will always be the opposite to that taken by the object in the visual field; for if the object be shifted to a higher plane, the lines (B B', C C') (Fig. 22) will fall on a relatively lower plane of the retina; and similarly, if shifted to the right, the image will be formed relatively to the left, and so on. This inversion of the image, both as regards itself and its position in the visual field, being constant, is disregarded, and consequently we perceive or *project* objects in their true position.

The Size of the Retinal Image.—This will vary directly with the size of the object, and inversely with its distance from the nodal point. It is evident that the nearer the nodal point is to the retina the smaller will be the image, and conversely the further the image is from the nodal point the larger it will be. The nodal point, however, is fixed 15 mm. in front of the retina in emmetropia, but a similar effect to moving the nodal point is obtained by varying the distance of the object from it, only in inverse ratio, recession of the object being equivalent to approximation of the nodal point to the retina, and conversely. Consequently, given the dimensions of the object and its distance from the eye, the size of the retinal image is expressed by a simple proportion sum thus:

The size of the image (B' C') is to the size of the object (B C)

as the distance of the nodal point from the retina ($C'N$) is to the distance of the nodal point from the object (NC); or—

$$B'C' : BC :: C'N : NC.$$

Therefore, for example, suppose BC to be 25 cm. in height, and to be situated at a distance of 3 m. from the eye:

$$\text{Then } B'C' = \frac{250 \times 15}{3000} = \frac{3750}{3000} = 1.25 \text{ mm.};$$

or, applying the same formula in its most practical manner to the dimensions of a blind area or scotoma:

Suppose the scotoma (s) has on the perimetric chart a diameter of 10 mm., the perimeter being at a distance of 330 mm. from the eye:

$$\text{Then } S = \frac{10 \times 15}{330} = \frac{150}{330} = 0.4 \text{ mm.}$$

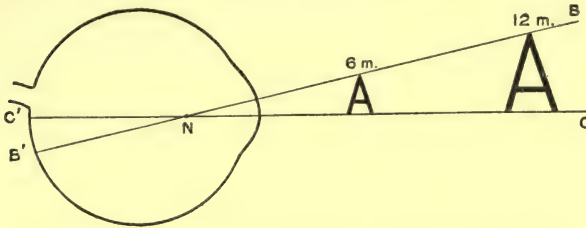


FIG. 22.—The formation of the retinal image (*see Text*).

This method of calculating the size of the retinal image will have to be slightly modified in ametropia. In hypermetropia the shortening of the antero-posterior axis of the eye will bring the nodal point nearer to the retina, whilst the increased length of the myopic eye will produce the opposite effect. Thus the retinal images in hypermetropia are slightly smaller, and in myopia slightly larger than in emmetropia. A fairly accurate alteration can be made in the equation by allowing 1 mm. of shortening or lengthening to every three dioptries of ametropia.

The Visual Angle.—Having seen how to calculate the size of the retinal image, we must now see what are the limits of visual perception with regard to the size of the object. This is estimated by the size of the *visual angle*, which is the angle an object makes with the nodal point (BNC) (Fig. 22). Reference to Fig. 22 will make it clear that this angle will alter under the same conditions as does the size of the retinal image, that is, it will vary directly as the size of the object and inversely as the distance of the object from the nodal point. As a retinal image must be of certain dimensions to be appreciated as a separate and distinct object, the limits of visual perception can be gauged by the size of this angle, and it is generally said that the ultimate point of distinct vision is reached when the object subtends a visual angle of $5'$. Under favourable conditions of light many people can slightly exceed this limit; but upon this basis the now universally adopted Snellen's test-types are formulated, and the power of discerning an object which subtends this visual angle of $5'$ is the recognised standard of normal visual acuity (*see also* page 28).

Fixation.—In order to view an object the eye is rotated, so that rays of light from the object fall directly on the macula lutea. This process is known as fixation, and takes place round a point (R) (Fig. 23) situated on the optic axis 14 mm. behind the cornea, which is known as the **centre of rotation**, whilst the line drawn from the object to the centre of rotation (VR) (Fig. 23) is called the **line of fixation**.

The actual course of the rays of light will be represented by a line (VN L) (Fig. 23) drawn from the object through the nodal point to the macula lutea, which is therefore called the **visual line**. It will be seen by reference to Fig. 23 that the visual line and the line of fixation do not correspond with the optic axis, but lie slightly to its inner side, and form angles (VRA and VNA) with it. For practical purposes these angles may be considered equal, and they are collectively known as the **angle gamma** (γ), or the angle subtended by the object and the optic axis. The angle gamma generally has a value of 5° in emmetropia, but it may increase to as much as 10° in hypermetropia, because of the abnormal shortness of the antero-posterior diameter of the globe, which brings the nodal point nearer to the retina. Conversely, in myopia, in which the antero-posterior diameter is increased, the nodal point recedes from the retina, and the angle gamma diminishes in value, and may sometimes become negative. It is evident that when the visual line corresponds with the optic axis there will be no angle gamma. As the visual line normally lies

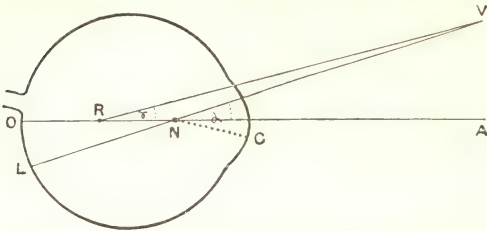


FIG. 23.—Diagram to explain the formation of the angles "gamma" and alpha. (After Landolt.)

to the inner side of the optic axes, an angle gamma of 5° will, when the visual lines are parallel, imply a divergence of the optic axes to an extent of 10° , and a large angle gamma may thus give rise to a deceptive appearance of a divergent strabismus. Similarly, a negative angle gamma, when the visual line lies to the outer

side of the optic axis, will cause a convergence of the optic axes which may be mistaken for a convergent strabismus. The differential diagnosis can always be made by the screen test (see "Muscles"), when it will be found that no deviation takes place in the eye behind the screen, showing that this eye still continues in a position of fixation.

The Angle Alpha (α).—This is of little practical importance, but requires passing notice. It generally happens that the cornea is not a segment of a perfect sphere but of an ellipse, usually with its apex slightly to the outer side of its centre. When this is so, the major axis of the cornea, instead of coinciding with the optic axis, lies slightly to its outer side and cuts it obliquely at the nodal point. An angle alpha (α) is then said to be present, and it consists in the angle formed by the visual line with the major axis of the corneal ellipse (VN C) (Fig. 23).

ACCOMMODATION, to which brief reference has already been made (page 11), is the alteration that takes place in the refraction of the

crystalline lens in order to adapt the eye to view objects at different distances from it.

The nearer an object is to the eye the more divergent are the rays that reach the eye from it, and the more powerful must be the convex lens to bring them to a focus upon the retina. Thus the necessity for accommodation increases inversely with the distance of the object from the eye.

Helmholtz's Theory of Accommodation.—The most generally accepted theory of the mechanism of accommodation is that of Helmholtz, which is briefly as follows (see Fig. 24).

The crystalline lens is an exceedingly elastic body, enclosed in a tough tight capsule, which is also of an elastic nature. This capsule is in communication with the ciliary body by means of the suspensory ligament.

When the emmetropic eye is at rest, that is, focussed for parallel rays, a tonic traction is maintained on the capsule of the lens by the suspensory ligament without the exertion of any muscular effort;

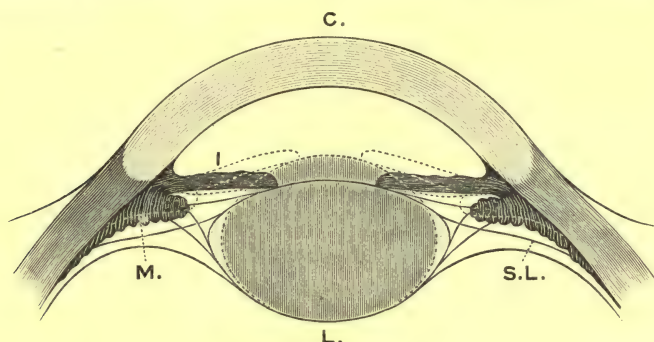


FIG. 24.—Helmholtz's method of accommodation. (Modification from Landolt.)

(L) Lens. (S.L) Suspensory ligament. (C) Cornea. (M) Ciliary muscle. (I) Iris. The dotted lines show the changes that occur during accommodation (see Text).

but as soon as the need for increased refraction, that is for accommodation, arises, a proportionate reflex contraction of the ciliary muscle, in which its annular fibres are chiefly concerned, takes place. This contraction, by approximating the apices of the ciliary processes to the lens, relaxes the suspensory ligament, and so lessens the traction of the latter upon the elastic lens capsule (see "Ciliary Muscle").

This, in its turn becoming relaxed, permits an alteration in the shape of the lens, which bulges forwards and, as a whole, becomes more spherical, with an increased convexity of its anterior surface, the amount of change depending upon the extent of the relaxation of the capsule, and the latter upon the degree of contraction that has taken place in the ciliary muscle. The posterior surface of the lens takes practically no share in this alteration in shape and curve, probably because of the pressure of the vitreous, which cannot be displaced as can the aqueous. It is probable that the process of relaxing the suspensory ligament is aided to a slight extent by the contraction of the longitudinal fibres of the ciliary muscle, which, by their insertion into

the extreme anterior portion of the choroid, drag the latter forward, together with the most posterior fibres of the suspensory ligament which are connected to it.

Tscherning's Theory of Accommodation.—Recently another theory has attracted considerable attention. Tscherning affirms that although the centre of the anterior lens surface increases in convexity during accommodation, this increase is not shared equally by the rest of the lens, but that the convexity is greatest at the centre and diminishes towards the periphery; so that at the most peripheral zones the convexity during accommodation is absolutely diminished, the lens in the act of accommodation becoming not more spherical, but rather assuming a hyperbolic curve. This alteration is effected by a tightening of the suspensory ligament, and not by its relaxation, as asserted by Helmholtz, the increase in the central curvature of the lens being effected by direct traction upon, and consequent depression of the peripheral portions of the anterior lens surface.

The exact mechanism of accommodation must be considered at present as *sub judice*. All that can be definitely affirmed as proved is

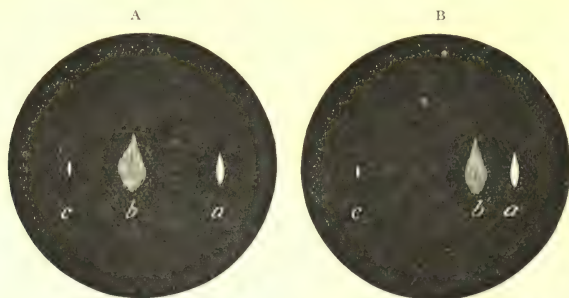


FIG. 25.—Purkinje's images. (After Donders.) (See Text.)

that the centre of the anterior lens surface increases its convexity during accommodation, and that the posterior surface does not appreciably join in any alteration of the lens shape.

With accommodation is associated a *reflex convergence of the optic axes* and a *reflex contraction of the pupils*, the latter, like the shutter in a photographic camera, having for its object the exclusion of unnecessary peripheral rays, which would blur the clearness of the image. The contraction is purely an associated action, for the pupil may be dilated artificially without impairing the reflex act of accommodation. The association of accommodation and convergence is mentioned again in dealing with convergence (page 19).

Proof of the Increased Convexity of the Lens in the Pupillary Area during Accommodation.—Direct a person to look into the distance in a darkened room. Take a candle and direct it so that its light falls obliquely on to the eye at about an angle of 30° with the line of fixation. The observer then looks into the eye from the other side, and will, with a little care, see three reflected images of the candle flame (*a, b, c*) (Fig. 25 A). They are known as Purkinje's images.

(a) is derived from corneal reflection. It is upright, the brightest of the three images, and situated the nearest to the candle.

(b) is derived from the anterior surface of the lens, and is the largest image of the three. It is also upright.

(c) is derived from the posterior surface of the lens, and is the smallest and most indistinct of the three. It is also inverted.

If now the observed eye is made to accommodate by bringing the object of fixation nearer and nearer to the eye, the following changes will be noted (Fig. 25 B) :

(a) remains stationary and unaltered.

(b) approaches (a) and becomes smaller. This proves that the lens has approached the cornea and that the convexity of its anterior surface has increased.

(c) does not change its position, but seems to become very slightly smaller.

Thus the only marked alteration in the images takes place in that derived from the anterior surface of the lens. It is found that the greater the accommodative power employed the nearer does (b) approach (a), and the smaller does (b) become.

This experiment may also be used to prove the presence of the lens in cases of doubt.

Measurement of Accommodation.—The elasticity of the lens and the contracting power of the ciliary muscle diminish with age, and therefore the power of accommodation as well. The age of greatest accommodative power is reached in early youth, at about the tenth year, and from that time it slowly diminishes, until at seventy-five years it has practically ceased to exist (*vide* "Presbyopia").

The amount of accommodative power possessed by an eye at a given time is known as its **range**, or **amplitude of accommodation**, and is generally and most conveniently expressed by the strength of the convex lens, the focal length of which represents the difference in the refracting power of the eye at rest, and that exercised when accommodation is strained to its utmost extent. To ascertain this difference we must first be acquainted with the distance of the furthest point of distinct vision from the eye, such point being known as the **punctum remotum** (R), and also with the nearest point of distinct vision, which is called the **punctum proximum** (P). The position of the punctum remotum must express the static refraction of the eye, and that of the punctum proximum the sum of the static and dynamic refraction. To find out, therefore, the dynamic refraction or amplitude of accommodation (A), we must subtract R from P, and this can be expressed in the form of a simple equation :

$$A = P - R.$$

Now, in emmetropia the eye is focussed for parallel rays, which are rays proceeding from an object situated at any distance over twenty feet ; therefore the static refraction in emmetropia may be said to be adapted for any distance over twenty feet, and the punctum remotum to be situated at infinity. In this case R becomes of no positive value, and A must equal P. For example, suppose we wish to ascertain the

amount of A in an emmetrope in whom the near point is situated at 15 cm. from the eye :

$$\begin{aligned}\text{Then} \quad A &= P - R ; \\ \text{But} \quad R &= \infty \text{ (infinity) } = 0 ; \\ \text{Therefore } A &= P = 15 \text{ cm.}\end{aligned}$$

The convex lens that has a focal length of 15 cm. is + 6.75 D ($\frac{100}{15} = 6.75$), and therefore the amplitude of accommodation is said in this case to amount to 6.75 D (*vide* "Metrical System," page 20).

In *myopia* parallel rays are focussed in front of the retina, and the eye is only adjusted for divergent rays, that is for those emanating from an object situated at a distance of less than twenty feet. Thus R must always be situated nearer to the eye in myopia than in emmetropia, and the greater the myopia the nearer is R to the eye. The same applies to P, but not in the same ratio, because an object must always lie at a certain distance from the eye to maintain clear vision. Thus in myopia the difference between R and P, and consequently the range of accommodation, must always be less than in emmetropia, and will diminish in inverse ratio with the degree of myopia; so that in very high degrees of this defect P and R may coincide, in which case it is evident that no accommodation can exist. For example, suppose R be situated at 9 cm. from the eye, which is equivalent to a myopia of 11 D ($\frac{100}{9} = 11$), whilst P is situated at a distance of 7 cm., which will be represented by a lens of 14 D ($\frac{100}{7} = 14$) :

$$\begin{aligned}\text{Then} \quad A &= P - R, \\ \text{Or} \quad A &= 14 \text{ D} - 11 \text{ D} ; \\ \text{Therefore } A &= 3 \text{ D.}\end{aligned}$$

In *hypermetropia* even parallel rays are focussed behind the retina, so that the accommodation must be employed in every visual act. Here, then, R must be a negative quantity, and can only be expressed by the value of the convex lens required to focus parallel rays upon the retina. It also follows that P must always be situated further from the eye than in emmetropia, according to the strength of the lens required to express R, and therefore in direct ratio with the degree of hypermetropia. To find A, then, the equation must be somewhat altered thus :

$$A = P - (-R), \text{ or } A = P + R.$$

For example, suppose a hypermetropic patient requires a convex lens + 4 D to view parallel rays distinctly, whilst P is situated at 20 cm., representing a lens of + 5 D ($\frac{100}{20} = 5$) :

$$\begin{aligned}\text{Then} \quad A &= 4 \text{ D} + 5 \text{ D} ; \\ \text{Therefore } A &= 9 \text{ D.}\end{aligned}$$

From the above the following deductions can be made :

1. That, with a given fixed punctum proximum, the amplitude of accommodation required to maintain distinct vision is less in myopia and greater in hypermetropia than it is in emmetropia.

2. That, given a fixed range of accommodation, the punctum proximum must be situated nearer to the eye in myopia, and further from it in hypermetropia, than it is in emmetropia.

In presbyopia P is constantly receding, so that P and R become slowly approximated, and A will cease to exist when $P = R$.

CONVERGENCE.—When we look at an object we regard it with both eyes, but see only one image. This is known as binocular single vision (see also page 26). When the object is situated at some distance (twenty feet or more), the optic axes are practically parallel, and no muscular effort is needed to maintain binocular single vision. But as the object is approached nearer and nearer to the eyes, and the rays from it become *divergent*, so, in order to fulfil the condition of binocular vision, the optic axes must become convergent to each other. This rotation inwards of the eyes is known as *convergence*, and is produced by reflex associated action of the two internal recti muscles, and is presided over by a special centre in the floor of the aqueduct of Sylvius.

Relationship between Accommodation and Convergence.—In emmetropia there is a constant definite connection between the amount of accommodation and the amount of convergence, so that the exercise of so many dioptries of accommodation is accompanied by an equivalent number of degrees of convergence. The latter is usually expressed in *mètre-angles*, *i.e.* 1 *mètre-angle* represents the degree of convergence associated with 1 dioptre of accommodation to view an object situated at 1 *mètre*. Thus, in (Fig. 26) if (ML) represents a line dropped midway between the centres of rotation of the eyes, an object placed at a distance of 1 *mètre* will induce a convergence of the visual line, so that it will make with (ML) an angle (ELM) which is termed a **mètre-angle**. As the object is approached this angle must increase, so that at $\frac{1}{2}$ *mètre* it is twice as large, or in other words, there will then be 2 *mètre-angles* of convergence, which will be associated with 2 dioptries of accommodation, and so on. In point of fact, this connection is not absolute, that is to say, that under certain conditions an excess of accommodation over the usual number of *mètre-angles* of convergence, or of convergence over accommodation, can take place at will. Such conditions occur in all forms of ametropia. In hypermetropia there is always the endeavour to increase the accommodation without a corresponding increase in convergence, whilst myopic patients are ever striving to converge without accommodating. Up to a certain point both hypermetropic and myopic patients are successful, but the over-exertion of the one function is very apt to produce serious subjective troubles (see “Asthenopia,” and “Heterophoria”).

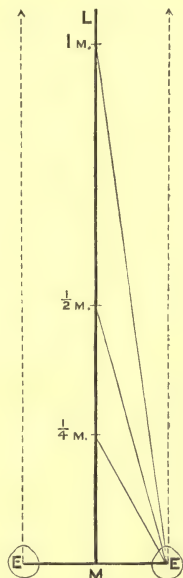


FIG. 26.—The *mètre-angle*.

divide thirty-seven by the number of the glass. Thus, take for example No. 17 of the old system. The number of times $\frac{1}{37}$ is contained in $\frac{1}{17}$ gives us the value of No. 17 in the new system. Now to divide $\frac{1}{17}$ by $\frac{1}{37}$ is equivalent to dividing thirty-seven by seventeen, and we have as a result $\frac{37}{17} = 2.25$ D. As the dioptric system is now almost universally employed, it is more often necessary to calculate the focal length of a lens in centimètres. Remembering that 1 D = 100 cm., all that is necessary to find the focal length of a lens is to divide 100 by the number of the lens in dioptries.

Thus 6 D has a focal length of 16.75 cm. ($\frac{100}{6} = 16.75$). In the same way we can calculate the dioptric equivalent of a lens of a certain focal length. Thus a lens of 16.75 cm. focal length is equivalent to 6 D ($\frac{100}{16.75} = 6$).

The following table shows the number of each glass in dioptries, and the corresponding number of the focal distance of the glass in Paris and English inches :

Dioptries.		Focus in Paris inches.		Focus in English inches.
0.25	...	148.00	...	160.00
0.50	...	74.00	...	80.00
0.75	...	49.30	...	48.00
1.00	...	37.00	...	40.00
1.25	...	29.60	...	32.00
1.50	...	24.60	...	27.00
1.75	...	21.10	...	21.00
2.00	...	18.50	...	20.00
2.25	...	16.40	...	18.00
2.50	...	14.80	...	16.00
2.75	...	13.40	...	14.00
3.00	...	12.30	...	13.00
3.50	...	10.50	...	11.00
4.00	...	9.25	...	10.00
4.50	...	8.20	...	9.00
5.00	...	7.40	...	8.00
5.50	...	6.70	...	7.00
6.00	...	6.10	...	6.50
7.00	...	5.20	...	5.50
8.00	...	4.60	...	5.00
9.00	...	4.10	...	4.50
10.00	...	3.70	...	4.00
11.00	...	3.30	...	3.70
12.00	...	3.08	...	3.50
13.00	...	2.80	...	3.00
14.00	...	2.60	...	2.80
15.00	...	2.40	...	2.70
16.00	...	2.30	...	2.50
17.00	...	2.10	...	2.30
18.00	...	2.05	...	2.20
19.00	...	1.90	...	2.10
20.00	...	1.80	...	2.00

CHAPTER III.

THE METHODICAL EXAMINATION OF THE EYE.

THE detection of the salient points of a difficult case can only be acquired by long practice founded upon attention to routine methods. Such a routine is now described, and though it occupies considerable space, yet the matter is so important that no apology is needed.

The methodical examination of the eye may be divided into six parts :

- I. *External Examination.*
- II. *Subjective Examination by Test-Types.*
- III. *Examination by Oblique Illumination.*
- IV. *Examination by the Ophthalmoscope.*
- V. *Examination of the Field of Vision.*
- VI. *Examination of the Colour Vision.*

I. EXTERNAL EXAMINATION.

Pathological conditions to which reference is made in this description will, in each case, be found discussed in detail in sections dealing with the diseases of the particular structure mentioned.

Eyelids.—The space left between the lids when the eyes are open is known as the palpebral fissure. Usually it is sufficiently large to expose about four fifths of the cornea, a small portion of the latter always remaining covered by the upper lid ; but its size varies within large limits, and is regulated by a tonic contraction of the levator palpebræ superioris muscle.

The main structure of the lid, the *tarsal ligament*, can be felt immediately beneath the skin, and it should be smooth and pliable, and fine down to the free border without any thickening or rounding of its edges or surface.

The lashes or *cilia* should be even, and distributed in two or three regular rows. Those of the upper lid are more numerous, generally longer, and curved upwards at their free extremities. Both sets should be directed away from the globe. The bases of the lashes should be

free from all incrustations. Examination should be made of the *puncta lachrymalia*. They should look rather backwards and lie applied to the ocular conjunctiva, so that the lid must be slightly drawn upon by the finger to obtain a satisfactory view of them. If everted, or too much inverted, they cannot perform their proper function. They may also be narrowed or practically obliterated from the contracting effects of old inflammation of the lids or conjunctiva. The lachrymal sac cannot be distinguished in health, but should it be enlarged or dilated by pus or retained fluid, the results of inflammation or stricture, it will form an ill-defined swelling at the inner side of the nose over the region of the tendo oculi, and pressure with the finger will often elicit fluctuation or regurgitation of fluid through the canaliculi and puncta. Obstruction in any part of the lachrymal canal will cause the tears to run down over the cheek, a condition which is known as *epiphora*.

Size of the Globe.—Note should be taken whether the eye is abnormally large or small. Very hypermetropic eyes are smaller, and very myopic eyes are larger than normal. An excessive condition of the former is known as *microphthalmos*, whilst extreme increase in size has received the name of *buphthalmos*, or ox-eye.

Proptosis or Exophthalmos.—By this is meant undue protrusion of the eye. The protrusion may be due to enlargement of the eyeball itself or to pressure from behind. When of marked degree proptosis is very evident; but when slight it is often difficult to decide whether the protrusion is real or only apparent, as any œdema of the lids or conjunctiva will give a prominent appearance to the eye. When in doubt the surgeon should place the patient in a chair with the head thrown backwards, and, standing behind, he should raise the upper eyelids with one finger of each hand, and at the same time should direct the patient to look towards the feet. From this position above and behind the patient the surgeon can glance down the face and contrast the level of the two eyes with each other, or compare their prominence with the projecting brow or with the side of the nose. Proptosis is a symptom common to all diseases within the orbit, and is also one of the principal symptoms in Graves' disease.

Tension.—By this term is meant the condition of the intra-ocular pressure. It varies within considerable limits even in health, but is then always such that the globe can be easily dimpled by palpation. It is generally slightly higher in old people than in young. Pathological alteration in tension is a sign of the highest importance, and it occurs in a great many diseases; but when it is of small degree it is often very difficult to determine whether the alteration is pathological or not, and it is therefore very important for the student to gain experience in this respect by palpating eyes on every opportunity. To ascertain the tension the patient should be told to gently close his eyes and look downwards whilst the surgeon places his two forefingers on the upper lid, and by an alternating pressure with first one finger and then the other, as if feeling for fluctuation, he determines the degree of tightness of the globe. The tension of one eye should *always* be compared with that of the other, as the normal condition of the

two eyes may be slightly above or below the usual standard of tightness.

To express the degree of tension, the following symbols, first introduced by the late Sir William Bowman, are now universally employed :

"T" represents *tension* ("t" being commonly used for tangent, the capital "T" is to be preferred).

"T_n" = *tension normal*.

The interrogative "?" marks a *doubt*, which in such matters must often content us.

The numerals following the letter "T" on the same line indicate the *degree of increased tension* ; or, if the "T" be preceded by the sign "—" (minus), they express the *degree of diminished tension*, as further explained below. Thus :

"T₃," *Third degree, or extreme tension*. The fingers cannot dimple the eye by firm pressure.

"T₂," *Second degree, or considerable tension*. The fingers can slightly impress the coats.

"T₁," *First degree. Slight but positive increase of tension*.

"T₁ ?," *Doubtful if tension is increased*.

"—T₁," *First degree of reduced tension. Slight but positive reduction of tension*.

"—T₂," } Successive degrees of reduced tension, short of such
 "—T₃," } considerable softness of the eye as allows the fingers to
 } sink in the coats. It is less easy to define these by
 } words.

Intra-ocular pressure is raised whenever—

1. Increased intra-ocular exudation of whatever kind is not followed by compensating increased excretion.

It may thus occur after severe intra-ocular hæmorrhages, or in the course of exudative inflammation of the uveal tract.

2. Obstruction exists to the normal excretion of intra-ocular fluids.

Under this heading will be classed all the non-exudative pathological conditions that occlude the important canal of Schlemm in the angle of the anterior chamber, such as intra-ocular tumours, glaucoma simplex, anterior dislocation of the lens, incarceration of iris or lens capsule, exclusion or occlusion of the pupil with *iris bombé*, etc.

Intra-ocular pressure is diminished—

1. After wounds with escape of the contents of the globe.

2. In the later stages of intra-ocular inflammation, when the volume of the eye begins to diminish from the shrinking of inflammatory exudates.

3. In large detachments of the retina.

Conjunctiva.—Both the palpebral and ocular conjunctiva should be perfectly smooth, lustrous, and transparent, admitting a clear view in the case of the palpebral conjunctiva of the reddish-yellow underlying tarsus, and in the case of the ocular conjunctiva of the pearly-white sclerotic. The palpebral conjunctiva is tightly adherent to the parts beneath, but upon the globe the conjunctiva lies loosely, and can be easily moved by the fingers.

It is important to distinguish the vessels that supply the ocular

conjunctiva and subjacent connective tissue from the anterior ciliary vessels supplying the iris and ciliary body. They are recognised as a few vessels originating at the periphery, becoming smaller as they approach the cornea, and moving with the conjunctiva when the latter is rubbed against the globe. The congestion of these vessels is an important feature in conjunctivitis, in which disease the circumcorneal zone is left comparatively white. In elderly people or in subjects of vascular disturbance these vessels are often tortuous and the veins congested.

The palpebral conjunctiva of the upper lid is examined by everting the lid as described in "Injuries of Cornea." Particular care should be taken to examine the retro-tarsal fold, that is, the place of reflexion of the conjunctiva from the lid on to the globe, which is frequently the seat of disease. The palpebral conjunctiva of the lower lid is easily examined by directing the patient to look gently upwards whilst the surgeon at the same time, with his forefinger, pulls the skin of the lid downwards, and at the same time presses somewhat backwards. By causing the patient to move his eye in various directions all parts of the ocular conjunctiva are easily brought into view, except the upper portion, which requires the surgeon to raise the upper lid whilst the patient looks downwards.

The Cornea should be bright and absolutely transparent. All irregularities in its surface, or any loss of transparency, should be noted. Both are the results of present or past inflammation or ulceration. Small foreign bodies, or the presence of faint *nebulæ* or superficial abrasions and the like, are most easily discovered by the methods of *focal or oblique* illumination. The cornea being non-vascular, the appearance of vessels upon any part of its surface is abnormal. It should be noted whether such vessels are really new vessels or belonging to a swollen congested conjunctiva which overlaps the corneal margins. In elderly people, rarely in those under forty years of age, the margin of the cornea is usually marked by an opaque whitish ring, which is known as the *arcus senilis*. It varies in completeness and extent in different people, being generally most marked on the upper and lower portions of the corneal margin. It never interferes with vision, and has no pathological significance. When no arcus is present the margin of the cornea should be clear-cut and sharply defined from the adjacent sclerotic. A leash of small vessels, derived from the anterior ciliary group, surround the corneal margin, dipping in at this point to supply the iris and adjacent parts. In health these vessels cannot be distinguished; but in inflammation of the iris and cornea they become congested, and then form a typical pink fringe round the cornea, known as ciliary congestion. This must be distinguished from congestion of the subconjunctival vessels, which is least marked towards the cornea, and is also of a darker and brighter colour. Very often both conjunctival and ciliary congestion are present together.

The Iris should be smooth and lustrous, and its striation should be clearly marked. The colour is often not uniform, being spotted with specks of a darker or lighter tinge than the main shade. A green hue or greyish striation is not infrequently the result of old inflammation.

The two healthy irides are generally the same colour, but not invariably so. The distance between the iris and the posterior portion of the cornea should be noticed, as we thus measure the depth of the anterior chamber. Both the depth and the equality in the depth of the anterior chamber are important points, as they are modified in many diseases. If the iris has lost the support of the lens from operation or traumatism it will fall back so as to greatly increase the depth of the anterior chamber, and it will also be tremulous, that is, it will quiver with each movement of the globe. Sometimes the iris is congenitally absent at its lower part, and such a condition is known as a *coloboma*.

The Pupils should be round and equal in size. Slightly oval pupils are sometimes a congenital abnormality, but inequality of size or irregularity in outline betokens disease in one or both eyes. The reflex actions of the pupils to light and accommodation should be carefully tested.

The Sclerotic should be of a uniform pearly-white colour, which has a bluish tinge when the sclera is rather thin, from the reflection of the subjacent choroidal pigment.

Motility.—Movements of the two eyes should be equal and simultaneous. Outwards the eye can be abducted just to the outer canthus. Inwards the eye can be adducted somewhat further than the inner canthus. The optic axes should lie in corresponding planes. Any deviation of one eye from the correct position is known as *strabismus* or *squint*.

Vision and Malingering.—Both eyes should be used to view an object. This is known as *binocular single vision*. For its maintenance it is necessary that the two images of the object viewed should fall upon exactly corresponding points in each retina. The images are then mentally fused and projected as one. Binocular single vision cannot therefore exist in squint. The great advantage gained by binocular single vision is *stereoscopic vision*, or the appreciation of *depth* in the picture. Each eye views the picture from a slightly different aspect, which causes the various objects in it to stand out solidly. Binocular vision may be absent although the eyes are correctly placed, owing to blindness or amblyopia of one eye, so that it is often necessary to test the patient before a definite conclusion can be reached. An easy test is to hold a small paper-knife or pencil before a book at some inches distance from it and direct the patient to read. If the print is blotted out behind the pencil only one eye is being used (see “Strabismus,” “Bar-Reading”). Another method is to place a piece of red glass before one eye and a piece of green glass before the other, and to direct the patient’s attention to a frame containing glass letters printed alternately in red and green. Each eye will be able to distinguish only those letters that are of the same colour as the piece of glass before that eye, so that it is only when binocular vision exists that all the letters in the frame can be read off.

Another method is as follows:—Place a prism of about 12° in front of one eye with its base outwards; if there is at once a corrective inward squint, we may be satisfied that the patient enjoys binocular vision. If, however, there is no movement of the eye, and no diplopia, it shows that the patient does not use that eye, but that he is looking with the other, and has

not, therefore, binocular vision. If now the prism is placed before the eye which he does use, it will at once move slightly inwards, but it will not be a corrective squint, for the non-seeing eye will at the same time go an equal distance outwards; this latter, however, is only an associated movement. This and the preceding mode of examining the eye are often of great service in detecting impostors, who, for some reason known only to themselves, are feigning the loss of sight of one eye—in many cases for the sake of compensation after injury.

The reaction of the pupil to light is also a useful test if malingering is suspected, as a patient has no control over his pupil reflexes, and the direct reflex will be absent if the patient is really blind.

Diplopia.—When two images of a single object are perceived the patient is said to suffer from *diplopia* or double vision.

Diplopia may be *binocular* or *monocular*.

Binocular diplopia is always due to strabismus, and is one of the symptoms that differentiate a strabismus due to paralysis of a muscle from a concomitant strabismus, in which the image of the squinting eye is suppressed.

Monocular diplopia, or double vision in one eye, may occur as the result of irregular astigmatism either in the cornea or lens. In a slight degree it is not at all uncommon from this cause, but generally it is only noticed when one eye is screened and the astigmatic eye is concentrated on some object. It sometimes occurs in commencing cataract from the same cause, but it is seen in its most pronounced form in partial dislocation of the lens, or in cases of double pupil from rupture of the iris (iridodialysis).

Polyopia, or multiple vision, is not uncommon in the early stages of cataract, and is due to the irregular refraction of the lens, whereby a number of confused images are seen instead of a single clear one.

II. SUBJECTIVE EXAMINATION.

This comprises the examination of the patient's vision by test-types and other subjective tests.

Test-types are of two kinds:

1. Types for determining the far point of distinct vision (punctum remotum).

2. Types for determining the near point of distinct vision (punctum proximum).

1. The types now universally used were introduced by Professor Snellen, and bear his name. They consist of rows of letters, the letters of each row being of the same size, and each row successively smaller than the one preceding it. Now the image that any object forms upon the retina is necessarily much smaller than the object itself, though in strict proportion to it. If the object is below a certain size its image will be too small to be differentiated by the retinal elements, and only a confused idea of its proportions will be received by the brain. A limit therefore exists in the size of objects for their clear perception, and such a limit is best expressed by the size of the angle which the smallest differentiated object makes at the eye. It

was estimated that to fulfil the condition of clear definition an object composed of two or more lines must be of such size that it subtends an angle of $5'$ at the normal eye (see also "Visual Angle," page 13).

It is evident that the further the distance from the eye the wider does the angle become, and the larger the object required to subtend it.

Upon this standard Snellen's test-types are erected. It is not strictly accurate, for reasons given below, but it is sufficiently so for the purpose. Each row is formed of letters that, at a given distance, subtend this angle of $5'$ at the eye. Thus the top largest letter represents the necessary size of an object if the angle is prolonged a distance of 60 m. from the eye. The next row will subtend this angle at 36 m., and the rows below at 24 m., 18 m., 12 m., 9 m., 6 m., and 5 m. respectively. Above each row is marked in dioptries or mètres the minimum distance at which it can be read ($D=60$, etc.). The examination is generally undertaken at a distance of 6 m., at which distance rays of light are practically parallel when they reach the eye, and accommodation is as far as possible eliminated. The examination can be conducted at a shorter distance, when rows of still smaller letters must be used, but the accuracy of the result will be seriously impaired if the patient is approached nearer than 3 mètres.

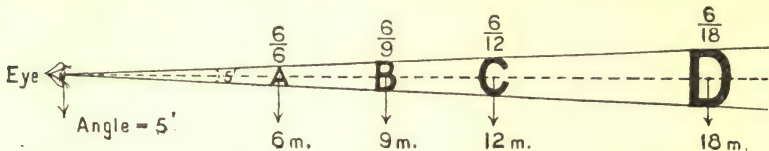


FIG. 27.—Shows the principle upon which Snellen's test-types are constructed (see also Text).

The acuity of vision of any patient will be represented by a fraction, the numerator of which is the distance at which he stands from the type, and the denominator the size of the smallest type he can read. Thus, if a patient can read at six mètres the type marked $D=6$ his acuity of vision is denoted by the formula V (vision) $= \frac{6}{6}$ or 1, *i. e.* normal. If the type $D=60$ is the smallest that can be read at this distance his vision is noted as $V = \frac{6}{60}$ or $\frac{1}{10}$ normal, and so on.

If the patient cannot distinguish the type $D=60$ at six mètres, his vision may be recorded as $V = < \frac{6}{60}$, or he may be approached nearer to the test-types, and the furthest distance noted at which $D=60$ can be seen. If this is found to be three mètres the formula will run $V = \frac{3}{60}$.

The test-types should be hung in a good light, and artificial illumination employed if necessary. Acuity of vision depends not only upon the healthy condition of the percipient elements (*retina* and *media*) and the normal state of the refraction, but also upon the *illumination* of the object, and it will be found that with good illumination many people can distinguish objects that subtend a smaller angle than $5'$ at the eye. Thus patients can often read at six mètres a line of letters marked $D=5$, and, very rarely, $D=4$ (see also page 13). Supposing that a patient is unable to discern the type $D=60$ at any distance, his acuity of vision may be tested by asking him to

count the fingers of the hand held up at different distances from the eye. If he can do this his vision is noted as $V = \text{fingers at } x \text{ feet}$. Supposing he is unable to do this, he may still be able to distinguish the movements of a hand in front of his eye, in which case his vision is noted as $V = \text{hand movements}$, or $V = \text{light perception (LP)}$.

To further test the power of light perception, the patient is seated in a dark room and the light from a lamp placed above his head is thrown upon the eye by a mirror, whilst the patient looks directly in front of him. The light should be cast from all quarters, and various degrees of illumination employed, so as to test the light perception of the different quarters of the visual field. The patient is directed to inform

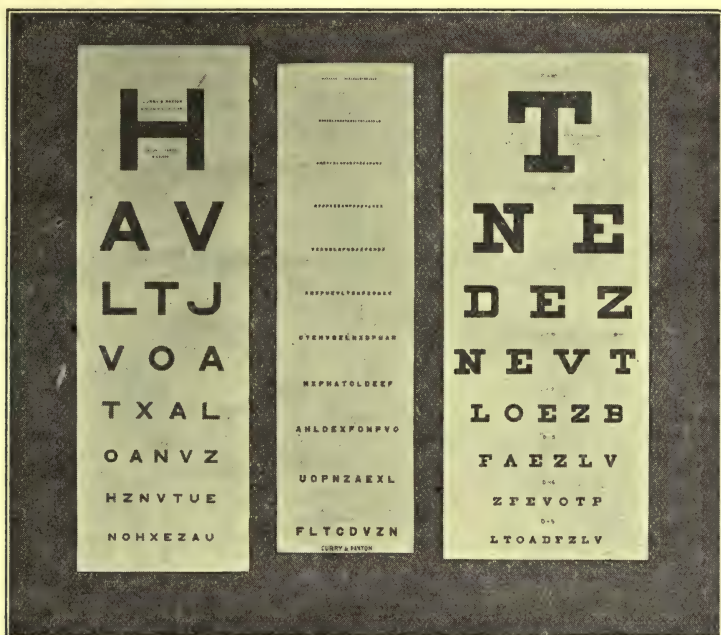


FIG. 28.—Snellen's test-types.

the surgeon immediately the light is perceived, and if the retina is healthy he should also be able to state correctly the direction from which the light is cast. The power of discerning the direction of the light is known as *light projection*, and is an important point in determining the healthy condition of the fundus in cases of cataract.

2. Having noted the patient's distant vision, his reading power and the position of the "punctum proximum" are tested by *Jaeger's types*, which consist of a series of paragraphs of different sized types from the smallest diamond type ($D = 0.06$ or Jaeger 1) upwards. They are arranged on the same principle as Snellen's test-types, but are open to the fallacies promoted by variations in the accommodative powers of different individuals. The patient, standing with his back to the

light, is directed to read the smallest type he can distinguish, which is recorded as Jaeger 1, 2, 4, etc. This method of testing visual acuity is chiefly useful as a subsidiary test or adjunct to Snellen's test-types, and the distance at which the type is read is as important for our conclusions as the size of the type itself. The capability of reading Jaeger 1 is present in most cases of myopia and moderate degrees of hypermetropia, and disability to do so may exist in emmetropia merely through the onset of presbyopia.

Having completed the external examination of the eyes and recorded the patient's distant and near vision in the manner above described, the surgeon next proceeds to try the effect of convex and concave lenses upon the vision. If the distant vision is $\frac{6}{6}$ the patient is either emmetropic or slightly hypermetropic, for myopia of the smallest degree will prevent a patient reading $\frac{6}{6}$. The point is settled by placing a low convex lens (+0.5 D) into trial spectacle frames (Fig. 29). If emmetropic, the vision is rendered worse thereby, improved or unimpaired if hypermetropic. When there is definite diminution in visual acuity ($V = \frac{6}{9}$ or $\frac{6}{12}$, etc.), we proceed to try and

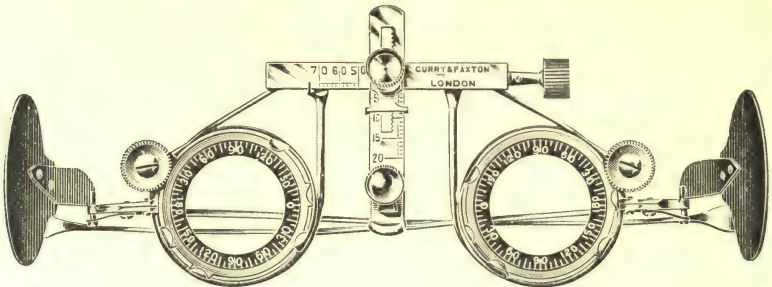


FIG. 29.—Landolt's trial frames fitted with Lang's adjustment.

correct the deficiency by convex or concave glasses, remembering that the *highest* convex glass corrects the manifest hypermetropia, and the *lowest* concave glass the myopia. Care must be exercised in ordering concave glasses in children that we are not misled by existing *ciliary spasm*.

If any deficiency in sight has thus been corrected the glasses may be ordered, and the case may generally be considered completed, except for an inspection with the ophthalmoscope, which it is a good routine practice to employ in all cases. If, however, glasses do not have the desired effect, and external examination has not revealed the cause, we must proceed to search for it by testing for astigmatism, and by examination with oblique illumination and the ophthalmoscope, having, if deemed necessary, first dilated the pupils by some mydriatic.

III. OBLIQUE OR FOCAL ILLUMINATION.

This consists in the examination of the eye by *reflected* light, and it is an extremely useful means of examining the surface of the cornea

or iris, and for ascertaining the state of the lens in cases of suspected cataract. It should be employed, in conjunction with the ophthalmoscope, to compare differences of appearance when an opacity is viewed by transmitted as well as by reflected light. The examination of the lens should, if possible, be conducted with the pupil dilated. The patient is seated in a chair in a darkened room. The ophthalmoscopic lamp is so placed that its light is on a level with, or a little in front of the patient's eye, and at about two feet distant from it. A biconvex lens of $+12$ D is then held so as to concentrate a cone of light upon the eye, when, by a slight movement of the glass in various directions, each part of the structure under examination is in turn illuminated until the whole of it has been satisfactorily explored. A second lens may be held in front of the eye, to be used as a magnifier if required.

IV. THE OPHTHALMOSCOPE.

Up to the year 1851, when Helmholtz introduced the first ophthalmoscope, it was thought that the blackness of the pupil lay in the absorption of light rays by the choroid. Helmholtz, however, demonstrated that rays of light that enter the pupil are not all absorbed, the greater number are reflected back again through the pupillary aperture; but these cannot, under ordinary circumstances, be perceived, because in attempting to intercept them the observer is unable at the same time to avoid shutting out the source of light by the interposition of his face.

The matter will be easily comprehended by the subjoined diagram. Let us suppose that (B)

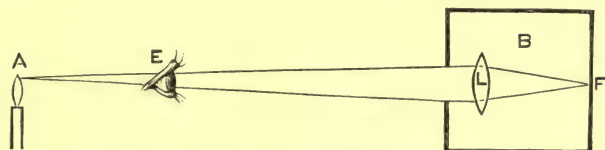


FIG. 30.—Diagram to illustrate the cause of the blackness of the pupil (*see Text*).

(Fig. 30) is a dark chamber comparable with the eye, fitted with a convex lens (L), and admitting light from (A) through a small aperture. Rays of light from (A), after passing through the convex lens, are brought to a focus at (F). Then, by the laws of convex lenses (F) and (A) are conjugate foci (*see page 4*), and rays reflected out of the chamber from (F) will, after emergence, meet again at (A). It will be obvious that an observing eye (E) placed so as to intercept these reflected rays will at the same time shut off the source of light from the chamber, and this will be true no matter where (A) is placed.

Supposing, however, that the convex lens was removed and the aperture considerably increased in size, then the illuminating rays from (A) would be reflected from the back of the chamber according to their angles of incidence (*see page 7*), and would not all pass back to the source of light. An observing eye might then, in some positions, perceive a few of the emergent rays and obtain a modified view of the interior of the chamber. An analogous condition may under certain circumstances be present in an eye from which the crystalline lens has

been extracted, or in which the retina is protruded by a growth or other cause. In either case so much irregular reflection may be produced that if the pupil is large the observer may, in certain positions, catch a glimpse of the red fundus reflex or of the displaced retina.

Helmholtz overcame the difficulty of illuminating the pupil by the brilliant expedient known as the ophthalmoscope, which, in its first and simplest form, consisted of a mirror perforated by a small central aperture, to which the observing eye is applied. By taking advantage of the reflecting power of the mirror, the light with which it was desired to illuminate the eye could now be placed to one side, and the mirror itself made to serve as the direct source of light; so that the rays reflected from the eye back on to the mirror were perceived through the sight-hole without causing any interference with the illumination.

The impression of the fundus thus obtained, however, was only a general one; the pupil looked red instead of black, but no clear image was received by the observer except under occasional circumstances. The reason of this lay chiefly in the refraction of the observed eye, which interfered with the theoretical paths of the reflected rays, and also to a less degree in the necessarily small size of the central aperture in the mirror, so that the rays could seldom be focussed or received in sufficient number on the observer's retina to form a clear image. These obstacles were surmounted by using a strong illuminator, such as gas, and by interposing a convex lens between the mirror and the observed eye, by which all the rays reflected from the retina could be gathered into a single focus, and thence, diverging, could all be easily brought to a second focus in the observer's eye, the latter thus perceiving not the direct image of the fundus, but an inverted aerial image formed by the convex lens somewhere between it and the observer's eye. It was necessary that the lens should be a powerful one, so as to collect all the rays and bring them to a focus not so close to the observer's eye, and therefore not so divergent when reaching the mirror, as to prevent a sufficient number from passing through the sight-hole; and by general consent a lens of two inches focal length (+12 D) was adopted as most suitable for the purpose.

In course of time, however, another method of solving the difficulty was found, *viz.* by approximating the mirror to the patient's eye and placing before the sight-hole a lens of sufficient curvature to neutralise the patient's refraction, and, if ametropic, that of the surgeon as well, by which means all the emerging rays would naturally come to a focus upon the surgeon's retina. The variations in the refraction of different individuals, and the difficulty in obtaining sufficient light with the close approximation of the mirror, were the obstacles to usefully employing this method. These were overcome by the invention of a magazine of lenses of varying strength which could be rotated in sequence before the sight-hole until one of a suitable power was found, whilst the necessary amount of illumination was obtained by tilting the mirror and providing an arrangement by which it could be rotated at will.

It speedily became evident that each method possessed special advantages of its own, and therefore it became necessary for the

perfectly equipped ophthalmoscope to be fitted so that either might be employed at will, that entailing the use of the convex lens becoming known as the “**indirect**” method of examination, in contradistinction to the other, which became styled the “**direct**” method.

In both *indirect* and *direct* examination the **mirror** employed is concave, because concave mirrors possess the advantage of concentrating or converging light rays. That employed for the indirect method has a focal length of ten inches, but for the direct examination a much more powerful one is needed, on account of its approximation to the eye, and a mirror of three inches focal length is therefore most commonly used. Whilst it is desirable that the mirror should be of ample size, this is necessarily limited in the direct examination by the peculiar way in which the mirror has to be adjusted and held; and in Couper’s and Morton’s ophthalmoscopes, which are those most

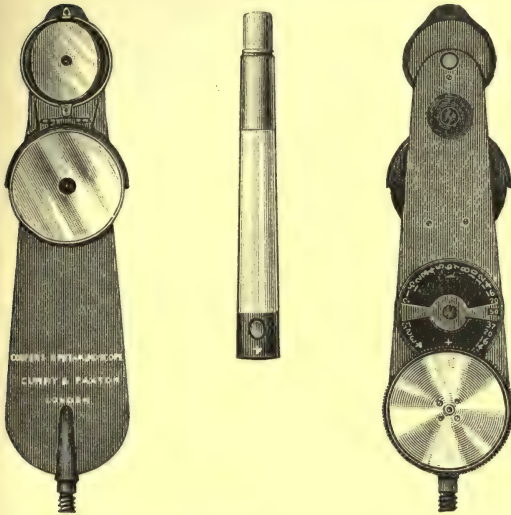


FIG. 31.—Couper's ophthalmoscope.

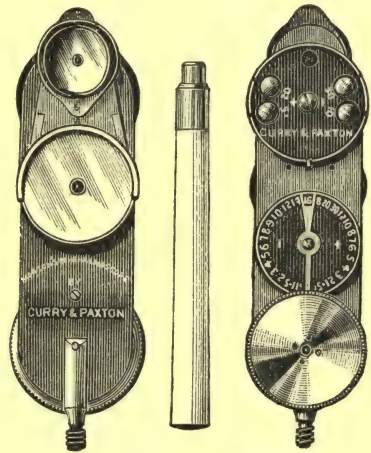


FIG. 32.—Morton's ophthalmoscope.

commonly in use, the direct mirror has a diameter of 18 mm., and is tilted to an angle of twenty-five degrees from the horizontal. The size of the central aperture is also of importance, especially in direct examination, because if in the latter case it exceeds that of the pupil to be examined, no clear image will be seen; and as it is often necessary to conduct the examination without a mydriatic, the aperture in this mirror is best made with a diameter of 2 mm., which is smaller than that usually employed for the indirect examination, which has a diameter of 4 mm.

There are many types of ophthalmoscopes in existence, varying in detail, but all modelled on the same general principles. The perfection of mechanism has, however, been reached in Couper’s, or Morton’s modification of Couper’s ophthalmoscope, which are figured above (Figs. 31 and 32).

With regard to the **image** obtained by the ophthalmoscope; this is in either case considerably magnified, though always much more so with the direct (about 15 diameters) than the indirect method (about 5 diameters). In both, however, the amount of magnification depends to some extent on the refraction of the eye being greatest in indirect examination in high hypermetropia and least in high myopia, whilst, when the direct method is employed, the largest image is obtained in high myopia and the smallest in high hypermetropia. In direct examination the image is always upright, whereas the indirect image, as already explained on page 32, is inverted, the upper corresponding to the real lower, and the right to the real left side.

The special advantages afforded by indirect examination are—

1. It exhibits a much larger field, and therefore gives a more general view of the fundus and the relative position of one object to another.
2. If the media are hazy it is possible in some cases to get an idea of the condition of the fundus by this method when one cannot do so by direct examination.
3. In very high myopia the magnification is so great by the direct method that the indirect affords the only satisfactory means of examination.

The special advantages afforded by direct examination are—

1. The large magnification obtained renders it the more useful method for the examination of details.
2. The refraction can be estimated at the same time that the fundus is examined.
3. Elevations and depressions can be accurately measured, whilst by indirect examination their existence can be appreciated only, not measured.
4. Opacities in the different refractive media can be located and examined.

From the above it will be understood that, as a general rule, both methods of examination should be employed, the one used to supplement the other.

HOW TO USE THE OPHTHALMOSCOPE.—Preliminaries to Examination.—It is a great advantage for the pupils to be dilated by a mydriatic, and in the case of beginners, especially, this advantage should always be secured. When once thoroughly conversant with the instrument, however, examination with the pupils undilated should be assiduously practised, because in very many cases we can obtain sufficient knowledge without submitting the patient to the annoyance and inconvenience of a mydriatic, whilst it also frequently happens that on account of increased intra-ocular tension or other reason the use of mydriatics is not permissible.

Thoroughly good illumination is essential; the room should be darkened, and the light must not only be bright and concentrated, but it must also be steady. Personally we prefer gas, with an Argand burner, to any other form of light, including the electric light, though the heat given off is somewhat of an objection. The lamp should be fitted to a movable arm, and placed to one side behind and on a level with the patient's ear. The patient should be seated in a comfortable

straight-backed chair, the surgeon using preferably a stool that can be adjusted to various heights as required and easily moved according as he wants to shift his position for the indirect and direct examination. It is a convenient plan for young children to stand leaning against the back of the chair or kneeling upon the seat, whilst if it is a baby that is to be examined it is often necessary to give the little patient a few whiffs of chloroform.

EXAMINATION BY THE INDIRECT METHOD.—The patient's right eye should be examined by the right eye of the surgeon, and his left by the surgeon's left, or the surgeon may use the same eye for both right and left examinations, the former method being certainly preferable when the use of the ophthalmoscope is being learnt, as both eyes are thus trained to the work. In any case the lamp placed to one or other side need not be shifted for the alternate examination of the two eyes.

Seated in front of the patient at rather less a distance than the



FIG. 33.—The indirect method of examination.

length of his arm, the surgeon holds the mirror close to his eye, and at such an angle that it reflects the rays from the lamp into the patient's pupil, which is at once illuminated by a red glare known as the fundus reflex. The next step is to locate the optic disc, which with its immediate area comprises the most important part of the fundus, and which, as being the largest and most conspicuous object, is an excellent landmark. The disc is situated a little to the inner side, so that it is not in view when the patient looks directly forward: consequently he should be directed, whilst keeping his head steady, to turn his eyes so as to look at the tip of the surgeon's ear most distant from the eye that is being examined, that is the surgeon's right ear in examination of the right eye, and conversely. The surgeon's little finger held up as in Fig. 33 may be used as a landmark instead of the ear if preferred. In this way the globe is slightly inverted, the optic nerve comes into the field, and the red glare is immediately replaced by one of a much

whiter hue that proceeds from the pale disc. As soon as the surgeon detects this whitish reflex he places the object lens, held between the forefinger and thumb of the other hand, in front of the patient's eye, about $1\frac{1}{2}$ to 2 inches from it, and steadies the lens by resting the tips of one or two disengaged fingers upon the patient's forehead. By moving his own head a little backwards or forwards, or by slightly altering the position of the lens, approximating, withdrawing, or slightly tilting it, the surgeon will soon succeed in bringing the optic disc into clear outline. This slight shifting of the head and lens can only be learnt by practice, and the beginner will also be much troubled at first by a reflection of the lamp from the surface of the cornea, an inconvenience that, however, he will learn in time to disregard.

Having examined the nerve and its vessels, the next point to seek is the macula lutea, which lies slightly to the apparent inner side and just above the upper margin of the disc. It is easily brought into the centre of the field by directing the patient to look directly forwards, and it is

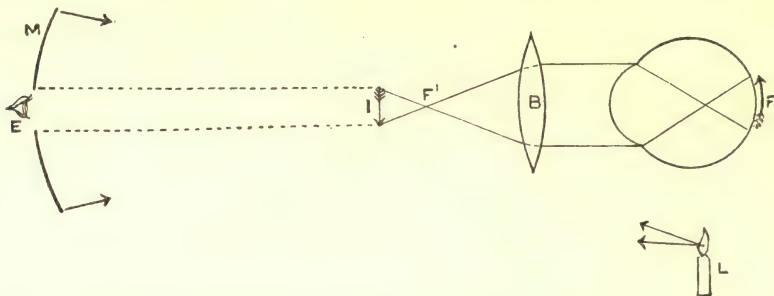


FIG. 34.—Course of *reflected* rays in indirect examination. Rays from the lamp (L) impinge on the mirror (M) and, passing into the eye, are focussed at (F). The reflected rays from (F), on emerging from the eye, pass through the convex lens (B), which brings them to a focus at (F'), where a small inverted aerial image (I) of (F) is formed. Thence the rays pass on through the sight-hole of the mirror (M), and are received by (E) the observing eye.

recognised by its brighter and darker reflex. If the pupil has not been dilated the extreme sensitiveness of this portion of the retina will cause a spasmodic contraction of the pupil as soon as the light falls directly upon it, and in such cases it is better to leave the examination of this portion of the fundus to the direct method (*vide infra*).

The rest of the fundus can be examined by causing the patient to move his eyes in various directions as required. If there are any opacities in the media they will appear as black spots or streaks interrupting the view, and should be further examined by oblique illumination and the direct method in order to locate their exact position, which cannot be done by indirect examination.

It is worth noting incidentally that the convex lens usually supplied with an ophthalmoscope is much too small. One of two inches diameter, and preferably fitted with a handle, is a good working size and not too heavy, and with it a better field is obtained and the corneal reflex is more easily avoided than is the case with a smaller lens.

THE DIRECT METHOD OF EXAMINATION.—The surgeon always sits on the side to be examined, using his left eye for the patient's left and his right for the patient's right. The position of the lamp is the same as that indicated for the indirect method, except that it must be always on the same side as the surgeon is sitting, and therefore has to be shifted for each examination. The mirror is arranged so that the apex or non-tilted edge points towards the surgeon's nose. The patient's head should be slightly inclined towards the surgeon's shoulder, whilst the surgeon similarly bends his head towards the patient, a close approximation between the eyes being thus obtained without the rest of the face being unpleasantly close.

As the surgeon sits rather to one side the optic disc is brought into view by directing the patient to look straight in front of him. If the pupil is dilated the macula is easily examined by the patient looking



FIG. 35.—The direct method of examination.

directly into the mirror, but if undilated this procedure is apt to cause such spasmodic contraction of the pupil that no view can be obtained, and in this case the macula is best seen by the surgeon slightly shifting his own head, whilst the patient still looks in front, a little manœuvre by which it is examined from a slightly lateral aspect, and the effects of the direct application of the light avoided.

The rest of the fundus is examined, as in the indirect method, by requesting the patient to move his eye in various directions as required.

The method by which a clear image is obtained has already been outlined on page 32, but it is now desirable to enter a little further into details. It will be evident that without an interposing lens the clearness of the image received on the observer's retina will depend upon the direction that the reflected rays assume on leaving the patient's eye, and upon the capability of the surgeon to focus these

rays upon his own retina. If the patient be emmetropic the reflected rays will emerge parallel, if hypermetropic they will diverge, and if myopic they will be convergent. If the observing eye be emmetropic parallel rays will be focussed upon his retina, provided that his accommodation is relaxed, and he will also be able to focus the divergent rays from a hypermetropic eye by virtue of his own accommodation, provided always that the degree of H does not exceed his accommodative power. The rays from a myopic eye, however, being convergent, must be brought to a focus in front of the retina of an emmetropic eye, however slight the myopia may be, and any accommodative effort on the part of the observing eye will only render such rays still more convergent, and focus them still further from the retina. Eliminating the question of accommodation, which, as will be seen shortly, it is essential that the surgeon should learn to relax at will, it is plain that if the surgeon be emmetropic he will only perceive a clear image when he happens to examine an emmetropic eye; whilst, if his own refraction be at fault, a clear image is only possible when his own refractive error neutralises that of the patient (see below).

Hence, then, the necessity for interposing lenses, the required one in every case being that which neutralises the refraction of both patient and surgeon, unless the surgeon chooses instead to wear his correcting glasses, when only the patient's refraction need be considered. In the former case the neutralising lens will always be represented by the *sum* of the two refractive errors. Thus, if a patient have $H = +5\text{ D}$ and the surgeon $H = +3\text{ D}$ the required lens will be $+8\text{ D}$; but if the patient have $H = +5\text{ D}$ and the surgeon $M = -3\text{ D}$, then, according to ordinary algebraical rule, the sum of the two will be a lens of a value $+2\text{ D}$; whilst, as a final example, if the refractions of the two are unlike in signs but equal in degree, as -3 D and $+3\text{ D}$, it is plain that one neutralises the other, and no interposing lens will be needed.

The Estimation of the Refraction.—There are three special points to be remembered.

1. *The surgeon must relax his accommodation.* This is a habit that can only be acquired with considerable practice. The best way to learn to do so is to examine an eye that is considerably hypermetropic, and, using the direct method, to rotate slowly convex lenses of increasing strength behind the mirror, endeavouring with each one to see clearly the details of the fundus. When he succeeds in doing so with a lens that corrects the H, he may be sure that he has succeeded in relaxing his accommodation.

2. The surgeon must be aware of the condition of his own refraction, and if he is ametropic he must either wear his correcting glasses or must *subtract* the amount of his ametropia from the total result obtained.

3. *The patient's accommodation should, if possible, be suspended by a mydriatic*; but if this cannot be employed, it can be relaxed by directing him to look straight into the distance—*through* the opposite wall as it were,—which serves a double purpose by bringing into view the optic disc and its vessels upon which the estimation is made.

The surgeon now looks steadily at the optic disc, which is chosen as being the most conspicuous object, and one upon which a steady view can be maintained, and whilst doing so, rotates convex or concave lenses, as the case may be, before the sight-hole of the mirror, until he has found the *highest* convex or the *lowest* concave lens with which the disc and its vessels are plainly seen. This lens, after the subtraction of any refractive error of his own, will represent the degree of H or M respectively. It is a difficult matter to estimate astigmatism by this method, especially if the meridians are oblique and the amount of astigmatism small, and retinoscopy is always to be preferred. It is effected by selecting two vessels lying as nearly as possible in the planes of the principal meridians, and by estimating the refraction for each, the astigmatism being represented by the difference between the two results.

A few examples will make the method of calculation and subtraction clear.

Let us suppose that the surgeon has $H = 3$ D, and that he is about to examine the refraction of four different patients.

In number 1 case he sees the fundus best with $+ 3$ D. Subtracting his own ametropia, this will mean that no error of refraction is present and the patient is therefore emmetropic.

In number 2 case the fundus is best made out with $+ 6$ D. After subtracting 3 D for his own refractive error, there is still left $+ 3$ D, which therefore represents the patient's refraction, and he has $H = 3$ D.

In number 3 case he requires $+ 1$ D to view the fundus. Here it is evident that 2 D of his own ametropia has been neutralised by the patient's refraction, which must therefore be of a contrary nature to his own, and the patient is therefore myopic to the extent of $- 2$ D.

In number 4 case the lens needed is $- 3$ D, and according to algebraical rule the difference between his own and the patient's ametropia amounts in this case to 6 D, for after the neutralisation of his own ametropia, which will require $- 3$ D, the patient is still myopic to the extent of $- 3$ D, the total error being therefore $M = 6$ D.

Estimation of the refraction by the ophthalmoscope is chiefly useful when we wish to gain a rapid idea of the patient's refraction, and it should not take the place of more accurate, though more laborious methods, such as retinoscopy, as a means of *correcting* refractive errors.

(*For estimation of astigmatism by the ophthalmoscope see also "Astigmatism."*)

The Measurement of Elevations and Depressions.—In calculating, these three points are to be borne in mind:

1. To view a **depression**, however slight, the surgeon will need a lens of *lesser* refractive power than that required for surrounding objects, whilst an **elevation** will need a lens of *higher* refractive power.

2. To turn the measurement calculated in dioptries into millimetres it may be assumed that a lens of 3 D is equivalent to an elevation or depression, as the case may be, of 1 mm.

3. The measurement as to width and size is most readily gauged by comparison with the optic papilla, which has a diameter of about 2 mm. in the adult normal eye, or the same thing may be expressed as so many **papilla-diameters**.

For example, suppose there be an object situated near the disc, and the latter can be best seen with $+2$ D, whilst the object itself is best viewed with $+8$ D, we conclude that we have to deal with something that causes an elevation of 2 mm. from the general level, and has a superficies of so many papilla-diameters. As in estimation of the refraction, the surgeon must allow for any ametropia that he possesses, and must relax his accommodation.

A swelling or depression can also be recognised, though not measured, by indirect examination by the presence of a "parallax." If the convex lens be moved slightly from one side to another it will be noticed that the vessels over the site of the elevated or depressed area

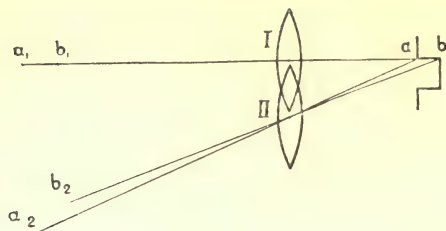


FIG. 36.—Diagram to illustrate parallax displacement. (After Fuchs.) (See Text.)

do not all follow the motions of the lens to an equal degree, so that with the movement of the lens in one direction they appear to get further apart, and upon reversal of the motion to approach each other again. The greater the alteration in level the more marked will be this parallaxic displacement of the vessels, so by this means a rough guess may be made as to

the measurement. The phenomenon will be easily understood by the annexed diagram (Fig. 36).

Let (*a*) be the anterior edge of an excavation, and (*b*) the base. If the convex lens be in the position (I) (*a*) and (*b*) will cover each other and appear as (*a*₁ *b*₁); but if the lens be moved to (II) (*a*) and (*b*) will appear to have taken the position (*a*₂ *b*₂), and to have altered their relative positions to each other.

Examination of the Refracting Media.—Opacities in the vitreous are recognised by their oscillations, which take place when the patient moves his head. They present very varied appearances, from the merest dancing specks to large sluggish masses, the range and rapidity of movement depending in every case upon their size, weight, and the extent to which the vitreous has become fluid. They are best seen with a lens of $+3$ D to $+10$ D, according to their position and the refraction of the eye, a plane mirror and rather a subdued light being the best way to make out the opacities when they are very fine and dust-like. Opacities in the lens are fixed, and a lens of $+10$ D to $+15$ D is needed for their examination according to their position. Opacities in the cornea can be examined with $+20$ D; but both in the case of the cornea and lens much information is obtained by employing oblique illumination in addition to the ophthalmoscope.

THE NORMAL FUNDUS.

The red glare of the fundus is due to reflection from the choroidal circulation and not to the presence of the retina, which is transparent.

We recognise the latter mainly by its blood-vessels, which are in prominent view as they course over the red background, and also in some cases by a faint greyish striation. It is in dark people that this striation is most easily made out. In Europeans it is usually confined to the immediate neighbourhood of the optic disc, but in the negro races it is universal, and gives the impression of a transparent veil lying in front of the choroid. In children, too, it is common to see a white shimmering reflex from the retina to which the term "*watered*" or "*shot*" silk retina has been applied, and which disappears in adult life.

The intra-ocular portion of the optic nerve, the **optic disc** or papilla as it is called, lies slightly to the inner side of the antero-posterior axis, and is the most conspicuous object in the fundus. Its colour is, in the main, of a pinkish hue, the gradations of which vary very considerably



FIG. 37.—The normal fundus. The central black spots on the disc mark the lamina cribrosa at the bottom of the physiological cup. The retinal vessels are seen curling over the superficial edge of the cup. The dark spot on the right is the macula lutea, and its central white point the fovea centralis.

in individuals within the bounds of health. In shape it is either round or oval, the direction of its long axis in the latter case frequently depending upon the refraction of the eye, and whether the direct or indirect method of investigation is being adopted (*see* "Astigmatism," page 76). Its margin is sharply defined, and usually bounded by a ring of pigment, generally incomplete or more marked on one side than the other, which is known as the "**choroidal ring**," and indicates the passage of the nerve through the choroid. Sometimes this choroidal opening is a little larger than the nerve itself, in which case a narrow ribbon-like band of white sclerotic, known as the "**scleral ring**," can be made out between the disc margin and the choroidal ring. The centre of the disc, which is much paler owing to the absence at this spot of the minute radiating vessels which elsewhere run over the face of the disc and give to it the pink hue above mentioned, marks the site of a central

depression known as the **physiological cup** (Fig. 37), which is produced by a peripheral expansion of the nerve to form the papilla after its constriction in its passage through the lamina cribrosa. It is funnel-shaped, with the apex pointing backwards, and varies considerably both in depth and width, but never involves the whole surface of the disc, and is thereby always to be distinguished from the *pathological* excavations occurring in glaucoma and optic atrophy (Fig. 38). If the cup is deep a faint mottling can be seen at the bottom, indicating the position of the **lamina cribrosa** (Figs. 37 and 38), while the superficial boundaries of the cup can always be marked, even in the shallowest cases, by the bending imparted to the main retinal trunks as they pass over its margin. The **central artery** of the retina, closely accompanied by its vein, emerges from the central cup, and at once divides into a

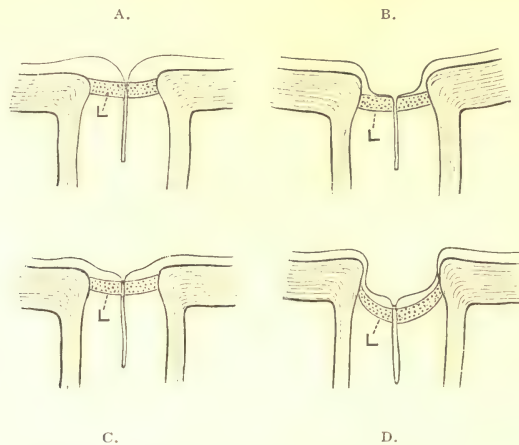


FIG. 38.—Cupping of the optic nerve. (After Fuchs and Priestley Smith.) A and B show varieties of *physiological cupping*. Both partial, with normal lamina cribrosa. In B the cupping is unusually deep (see also Fig. 48). C and D show varieties of *pathological cupping*. Both involve the whole nerve. C represents the shallow cup of optic atrophy; D the ampulliform excavation of glaucoma with backward displacement of (L) the lamina cribrosa.

superior and inferior division, each of which subdivides again near the edge of the disc into large nasal and temporal trunks to supply corresponding portions of the retina. Following the course of one of these branches it will be seen to pursue a devious and often tortuous path, dividing and subdividing dichotomously, whilst close at hand lies the companion vein, the two occasionally intertwining or crossing each other. To each branching twig is assigned the supply of a certain area, and as no anastomoses with other offshoots occur, the cutting off of the circulation through any one of them is followed by the death of that portion of the retina which it supplies. The retinal circulation is, however, sometimes aided by a branch from one of the ciliary arteries known as a *cilio-retinal* artery, which either passes through the lamina cribrosa and emerges near the margin of the nerve-head, or

pierces the choroid adjacent to it, and may be the means in some cases of establishing a slight collateral circulation. The retinal arteries are to be distinguished from the veins by their brighter colour, smaller size, and by the presence of a narrow glistening streak called the "**arterial reflex**," which is important as a guide to the healthy condition of the vessel walls. The arteries, too, never exhibit pulsation in health; whilst the veins frequently do so, especially as they pass over the disc. It is to be remembered that, as in other parts of the vascular system, the central retinal artery may often exhibit slight anatomical variations in its exact course and method of division from that just described; but such details are unimportant and need no special mention.

A little to the outer side of the disc, at a distance of about $1\frac{1}{2}$ papilla-diameters, and slightly below it, lies the "**macula lutea**," which may be recognised as a small, oval, ill-defined area of a darker colour and a brighter reflex than the surrounding retina, and having no retinal vessels in its immediate neighbourhood. In its centre is a minute depression, the "**fovea centralis**," the appearance of which varies considerably, sometimes being clearly mapped out as a yellowish-white dot, whilst in other cases it is represented by a bright scintillating point.

In many normal fundi, especially in fair people, the choroidal pigment is not sufficiently dense to conceal the choroidal vessels, which are then seen as pale ribbon-like streaks, strikingly flat and straight as compared with the superjacent retinal vessels, and, unlike the latter, branching and anastomosing freely in every direction. In other cases the choroidal pigment is more marked in the vascular interspaces than over the vessels themselves, so that the fundus is marked out into a series of darker and lighter areas, a condition which is known as **tesselated fundus**, and must not be confused with any pathological condition of the choroid.

V. THE FIELD OF VISION.

This consists of two parts—(1) that of central or direct vision, and (2) that of peripheral or indirect vision. By *central vision* is meant the perception of objects in the line of the visual axis, that is, of objects at which we look directly. It is therefore the area of keenest vision, and is controlled by the macula lutea and the retina adjacent to it. By *peripheral vision* is meant the general sense we have of surrounding objects other than those upon which the gaze is fixed, and this is supplied by the outlying or peripheral portions of the retina.

A knowledge of defects and variations in the limits of the visual field is of the highest importance in the diagnosis, prognosis, and treatment of many eye affections; but until the perimeter was devised by Forster an insuperable difficulty lay in the curved superficies of the retina, which made it impossible to accurately project its impressions *directly* upon any surface that was flat. With the perimeter, the most improved form of which is shown below (Fig. 39), the projection is

first effected on to a hollow sphere representing the curved retina, and is *thence* transferred to a specially devised chart.

The method by which the perimeter is worked will be made clear by the following short description with reference to Figs. 39 and 40. The patient sits supporting the chin on a rest, and directs his gaze on a fixed point (P), generally made of ivory to attract attention, care being taken that the eye to be tested (E) and the point (P) are on the same level. Round (P), as a fixed centre of rotation, a curved arm (PA) can be made to revolve at the will of the operator, so that a complete revolution of (PA) bounds the half of a hollow sphere with its pole or centre of curvature at (P), and with a radius equal to (PA) or (PE), which are supposed to be similar. By causing (E) to look at (P), and adjusting the two to the

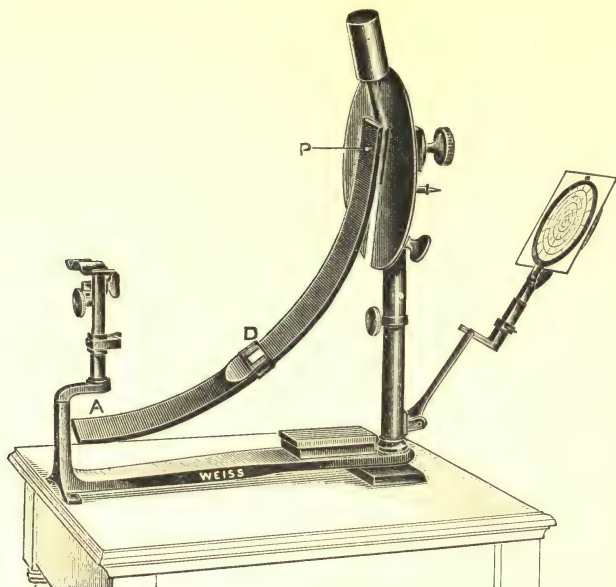


FIG. 39.—MacHardy's perimeter.

same level, (P) corresponds exactly to the fovea centralis or central point of the macula lutea, and this hollow sphere will accurately represent on an enlarged scale a retinal superficies of 90° in every direction from the macula as the pole.

It will be understood that the length of (PA), that is, the distance between (E) and (P), in that it only affects the *size* of the circle described and does not interfere with (P) as the centre of rotation, is immaterial up to a certain point. It must not, however, be too short, so as to strain the converging power and to tire the eye whilst being examined; and it must not be too long, because then a very short-sighted person could not see (P), and the instrument would also become very unwieldy. Consequently it was necessary to decide upon some length that would be suitable under as many varied conditions as possible, and in

MacHardy's perimeter the distance between (E) and (P) is regulated to thirteen inches.

Along (PA) a disc (D) exhibiting a square of white paper can be moved either forwards or backwards, its movements, by an ingenious arrangement, being followed on a reduced but corresponding plane by a metallic needle, which can record the position of the disc at any spot by pricking a hole on a specially devised chart (Fig. 41).

Whilst (E) steadily looks at (P) the disc (D) is slowly moved along (PA) from the periphery until (E) becomes conscious of the presence of the white square, whereupon the position of (D) is recorded upon the chart, and the arm (PA) then moved to a fresh meridian, with a repetition of the same process until the whole circle has been completed; the number of meridians to be examined in this way depending upon the accuracy required in any particular case.

The perimetric chart is divided up, just as in the projection of the world upon a map, by concentric circles and radiating lines into

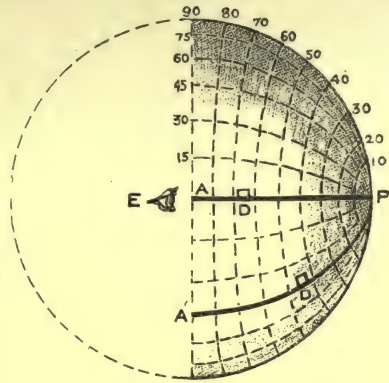


FIG. 40.—Schematic representation of the projection of the retinal superficies by the perimeter (*see Text*).

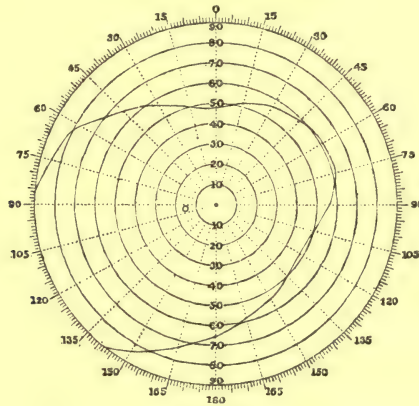


FIG. 41.—The map of the retina or perimetric chart. The contained line marks out the limits of the normal visual field in the left eye. The left-hand side, therefore, represents the outer, and the right-hand side the inner visual field. The small circle slightly to the left of the centre or "fixation point" is Mariotte's blind spot, and marks the site of the optic nerve.

meridional spaces, by means of which any spot can be exactly located in degrees from the centre, the latter corresponding to the macula and being known as the **fixation point**. The chart is placed in a frame which can be advanced towards or moved away from the needle, but

does not follow its excursions; the frame being so adjusted that the centre is always pricked by the needle when the latter rests at (P), whilst the size of the chart is regulated to a scale to correspond with the planes upon which the movements of the needle take place.

It will be seen by reference to Fig. 41 that the field of vision for white objects, marked out in the manner described, is not circular but more or less pear-shaped, being most contracted upwards and inwards, where it is limited by the projection of the orbital arch and nose, and of widest limit outwards, where at one point it extends a little beyond the 90° , and therefore just oversteps the limit of the chart. The field for all colours is much smaller than that for white, that for blue being the

largest, that for green the smallest, whilst red is intermediate in size between the other two. In binocular single vision the two fields overlap each other to a large extent, amounting to about the central two-thirds of the combined fields. A heart-shaped area is thus formed, which is known as the **field of binocular vision** (Fig. 42), and it will be seen that it extends to nearly 60° from the fixation point. This is bounded on each side by that outlying portion of the field which belongs to one eye alone, and which re-

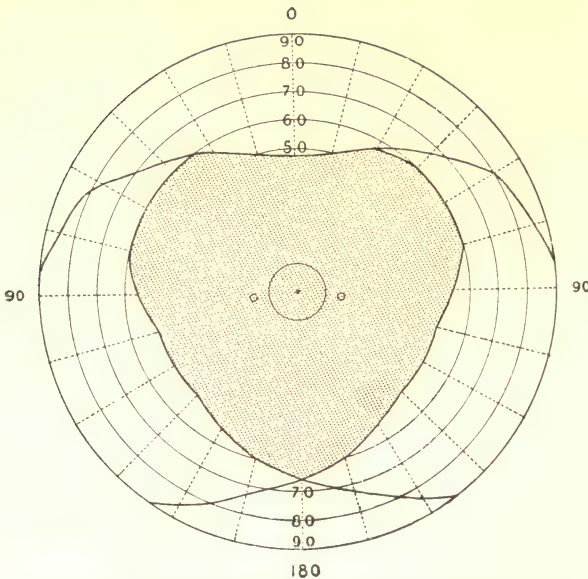


FIG. 42.—Chart representing the field of binocular vision. The shaded area represents the region over which the two eyes are combined for vision, which is bounded laterally by an area over which the eyes act separately.

presents the sum of *actual* loss of vision entailed by the blinding or removal of it.

In many diseases the visual field is broken by islands of defective sight, or **scotomata**, which are divided into two classes: (1) *relative scotomata*, in which the sight is merely defective, and (2) *absolute scotomata*, in which the loss of sight is complete. It is as well to mention here that every field possesses an absolute scotoma of physiological origin, which is known as Mariotte's blind spot and is due to the optic papilla, over which, of course, the retina is not formed (Fig. 41). Scotomata may be detected in colour sight as well as white sight, and in speaking of a scotoma it is desirable to specify whether it is as regards white or coloured objects, and, if the latter, to ascertain if some or all colours are involved. For although the perception of

a white object is keener than that for any colour, so that a scotoma for white necessarily implies a scotoma for colours as well, nevertheless the degrees with which white and coloured vision are affected may vary, and a relative scotoma for white is frequently accompanied by an absolute scotoma for colours, whilst a scotoma may be absolute for one colour and only relative for another, or may be confined to one colour whilst the others escape. Both relative and absolute scotomata, unless of very small size, may be mapped out by careful use of the perimeter, by directing the patient to stop the movement of the disc as soon as it becomes blotted out or partially lost to view. To ensure accuracy as to its limitations only a small test-square, one of 5 mm. or even less, should be employed; a further reason for this being that a comparatively large area in which the scotoma is only relative may bound a small space where it is absolute, and the latter may pass unrecognised and the whole scotoma be classed as relative if the test-square be too large.

Scotomata are also sometimes classed as *positive* and *negative*, positive scotomata being those of which the patient is himself conscious, and negative scotomata those of which the patient is unaware, but which are revealed by the perimeter. The actual loss of sight entailed by a scotoma depends, indeed, upon three factors: (a) its situation, (b) its size, and (c) whether it is or is not symmetrical. A scotoma affecting one eye only *may* pass unperceived by the patient even when of large size and affecting the central vision, because the gap is filled in by the vision of the other eye; whilst if it is located near the confines of the field it is almost certain to be unnoticed unless very large, because this area is never employed in directly looking at an object. The patient may likewise be unaware of symmetrical scotomata if situated in the peripheral field, whereas if they involve the central area to however small an extent he at once becomes conscious of the defect in every visual act. Symmetrical central scotomata are, therefore, the most obvious as well as the most important of all such defects, and their gravity is enhanced because, beyond the local disturbance in sight, they often indicate some specific disease of the nervous system.

Equally important as scotomata are **peripheral contractions** of the visual field, with which scotomata must not be confused, and which may take the form either of a sectorial invasion in which a slice is, as it were, removed at one particular spot, or of a more even, general contraction of the whole or of a great part of the field, the two varieties not infrequently being combined in the same field. In glaucoma, especially, the careful estimation of the limits of the visual field taken from time to time affords the most valuable information as to the progress of the disease and the propriety of operative measures.

In conducting a perimetrical examination attention should be paid to the following *general* points:

1. See that the light is good. Bad light must necessarily affect the visual acuity. The patient should sit with his back to the light, and the latter should shine directly on to the instrument.

2. Do not use too large a test-square. For ordinary purposes one of 10 mm. is quite large enough, but if the light is not very good a somewhat larger one—15 to 20 mm.—may be employed.

3. Take care that the chart sits truly in the frame and is not tilted to one side or the other.

4. Remember that the charts give an inverted diagram of the retina, so that a defect lying down and out on the retina is marked up and in on the chart, etc.

5. Take care that the patient continues to fix the ivory point whilst the disc is being moved. Patients are very apt to take their gaze off the point to see if the disc is coming, and so the surgeon must be constantly on the look-out for this, and start the examination of that meridian again if the eyes are moved.

6. Remember to block off carefully the eye not to be examined, especially on the outer side. Suitable reversible block-out frames can be obtained for the purpose, or a well-fitting shade may be used.

7. Deeply-set eyes, especially when in addition the nose is very prominent, cause some extra contraction of the field upwards and inwards, which must be taken into account.

8. See that the level of the eye and the fixation point are properly adjusted. There is a special mechanism in MacHardy's perimeter for regulating this.

When no perimeter is at hand the visual field can be roughly tested in the following way :

The patient should be placed about one and a half feet in front of the surgeon, and having closed his sound eye with his hand, he should be told to look steadily with the affected one at the nose or the eye of the examiner. Whilst the eye is thus fixed, the surgeon should keep one or both of his hands moving gently along the line of the circumference of an imaginary circle which about corresponds with the normal field of vision, carefully noting those points at which the patient says the hand becomes either indistinct or lost. If the patient should be unable to distinguish the movements of the hand at one and a half feet it may be approximated to the eye, and a smaller circle be described, the parts at which the sight is the most defective or wanting being still accurately observed.

The perimeter can also be used to find out the range of movement that each eye possesses for fixation ; that is, how far the eye can be turned in each direction so as to bring an object into the line of direct fixation. This is called the **field of central fixation**, and it is of importance as a measure of the normal excursions of the eye, and so useful in dealing with squint. A small square marked with dots or minute letters is moved along the arc of the perimeter through the various meridians towards the periphery, whilst the patient, following the card with the eye but keeping his head immovable, sees how far he can still count the dots, the limit being recorded in each meridian on an ordinary perimetric chart. In a normal case the chart will show that the range of movement is nearly circular and extends to about 50° in each direction, being a little less than this above and internally and slightly more downwards and outwards.

The angle of a squint may also be accurately determined by the perimeter in the manner described in the article on "Strabismus."

VI. COLOUR VISION.

The two theories that are generally favoured to explain the origin of colour vision are those of Young-Helmholtz and Hering. The former theory supposes the existence of three primary colours—red, green, and violet. Corresponding to these colours there are three sets of nerve terminals in the retina, each of which can only be set in action by its own particular shade—either red, green, or violet. The perception of a particular shade or colour lies in the excess of stimulation of one set over another. According to Hering's theory there are three sets of visual substances, each set being composed of a colour and its complement or antagonistic colour. Thus there are the red-green, the yellow-blue, and the black-white substances. Light-rays produce molecular changes in one or more of these substances, either in the form of assimilation or construction, or dissimulation or disintegration. According to the nature of the molecular activity, either red or green, yellow or blue, black or white is perceived, and it will be evident that many shades of colour might be produced by a combination of changes in each visual substance.

Defects in colour vision, or colour-blindness, may be *physiological* or *pathological*.

Physiological Defects.—Congenital colour-blindness may be complete, in which case the subject confuses all colours indifferently; or more commonly it is incomplete,—that is to say, some colours are confused whilst the perception of others is normal. The most frequent variety is an inability to distinguish red shades, or red-blindness, with which, as a rule, more or less green-blindness is associated as well, whilst blues and yellows are the colours which are least often affected. The condition is absolutely unamenable to treatment, and its chief importance lies in the detection of colour-blind persons who are candidates for entry into services where defects in colour vision constitute a danger to public safety. The most superficial examination will reveal the defect in one who is completely or markedly colour-blind, and difficulty in detection is confined to a large class of persons who are only partially defective. Many of these are quite unconscious of their deficiency, and have learnt by experience to connect certain erroneous impressions in their own mind with the names of certain colours, which on examination they may designate correctly, though apt to confuse them on an emergency. Others, again, conscious of their weakness, may by dint of some practice and a little cunning be sufficiently expert to deceive the examiners when the test consists in the correct naming of various colours. Hence any examination which consists in requiring the subject to designate a colour by name is apt to lead to wrong conclusions, and pass as sound many defective cases. The only accurate method has as its basis the matching of sample shades from an assortment of various colours. The patient is not required to speak, but simply to select shades approximating to the sample given, and this is precisely what a colour-blind person cannot do, as he immediately becomes confused.

No better method of applying this test is to be found than that devised by Professor Holmgren, which consists of a collection of small

skeins of coloured Berlin wools, each of which is loosely twisted up. In this bundle is included wools of red, orange, yellow, yellow-green, pure green, blue-green, blue, violet, purple, pink, brown, grey, several shades of each colour, and at least five gradations of each tint from the deepest to the lightest.

These worsteds being placed in a pile on the table, the examiner lays aside a skein of the especial colour desired for the examination. He then requires the patient to select from the wools other skeins which most closely resemble the colour of the sample and to place them by its side. The colour-sight of the patient is decided by the manner in which he performs this task.

Test 1.—Select as the sample skein the palest (lightest) shade of very pure green, which is neither a yellow-green nor a blue-green to the normal eye, but fairly intermediate between the two.

If the patient makes mistakes and matches the sample with light shades of grey, brown, or other light dissimilar colours, he is colour-blind.

The next test is to ascertain the form of colour-blindness.

Test 2.—A red-mauve skein is chosen for the sample. The colour should be midway between the darkest and the lightest shade. If the patient matches it with blue or violet, or one of them, he is *red-blind*. If he matches the red-mauve with green or grey, or one of them, he is *green-blind*.

Test 3 is a confirmatory test, and specially useful in examining the colour-sight of those employed in reading signals. Select a vivid red skein, like the red flag used for signals on railways, a bright yellowish red, and a scarlet. The red-blind will match the sample with a dark green or dark brown, with shades which to the normal eye are darker than the scarlet. The green-blind will select light green or light brown to match the scarlet, shades which are lighter than the sample.

Pathological Defects.—These are common in disease of the nervous structure of the eye, and accompany the general loss of sight in optic atrophy. Central colour scotomata form a prominent and early symptom in retro-bulbar neuritis. When small they cannot be detected by Holmgren's wools, as the general colour impression remains undisturbed, but they are easily evolved by exhibiting a small coloured square on the perimeter, or by holding up a small piece of coloured paper before the patient. Green is the colour affected earliest and to the largest extent, and red next to it, whilst blue often escapes altogether. Abnormal colour sensations may occur under many conditions. Thus patients afflicted with optic atrophy not infrequently see everything tinted of a green or violet hue, and after exposure of the eyes to an intense light objects appear surrounded by a red or golden haze. The extraction of a cataract is sometimes followed by red vision, which, however, generally passes off after a time (*see also* "Aphakia"). To another class belong certain psychical sensations of colour which come on when the eyes are closed, and consist in visions of gorgeous hues which seem to float before the eyes. They are, perhaps, of especial frequency in people absolutely blind, and in some cases of incipient insanity.

For colour-fields *see* "Field of Vision," page 46.

CHAPTER IV.

HYPERMETROPIA (SYMBOL H).

HYPERMETROPIA is a condition of ametropia characterised by a diminution in the normal static refraction of the eye, so that parallel rays of light are not correctly focussed on the retina, but if produced will meet at some point behind the retina (Fig. 20, page 12). A hypermetropic eye is therefore only adapted to focus convergent rays on the retina, and as rays emanating from an object are always divergent or parallel, but never become convergent, such an eye can never in a state of repose form any clear image, but must always rely upon its accommodation for every clear visual perception.

Measurement of H.—In a hypermetropic eye the far point of distinct vision can have no positive value, and can only be rendered diagrammatically. Suppose rays of light (A B) (Fig. 43) are made so convergent that by the static refraction of the eye they are brought to a focus on the retina at (F). Such rays traced backward will on emerging from the eye be divergent, and will appear as though emanating from a point (R) behind the eye. This point will represent the “punctum remotum” of the eye, and its position will be determined by the divergence of the emerging rays; for the greater the divergence of these rays, and consequently the greater the amount of H, the nearer will (R), the punctum remotum, be to the eye. The position of (R), then, can be taken as a measure of the degree of H in any given case; but as we cannot in practice directly estimate the position of (R), we express the degree of H by the value of the convex lens that renders parallel rays of light (A B) (Fig. 44) so convergent that by the additional aid of the refraction of the eye they are brought to a focus at (F) on the retina.

Such rays, if refracted by the lens alone, would be focussed at (R), and therefore the focal distance of the lens will coincide with the position of the punctum remotum, whilst its dioptric value is employed to

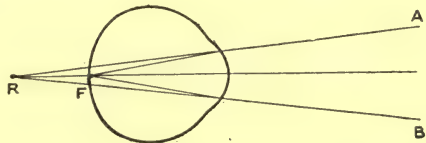


FIG. 43.—The formation of the “punctum remotum” in H.

represent the degree of H. Thus, if it is found that with a convex lens of + 5 D parallel rays are clearly focussed on the retina, 5 D of hypermetropia are present, and the punctum remotum is situated 20 cm. ($\frac{100}{5} = 20$) behind the cornea. This calculation is based on the assumption that the lens is touching the eye, which, of course, in practice it does not do. The distance, 1 cm., at which the lens would lie in a spectacle frame is so small that it is not taken into practical account; but were it removed to, say, 5 cm., then, in the case just

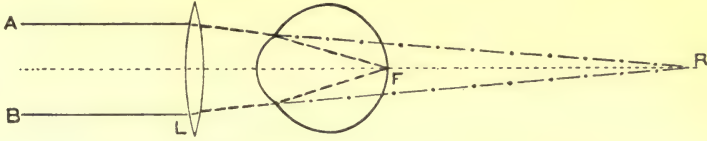


FIG. 44.—The measurement of H by a convex lens.

considered, the value of the lens would be increased 1 D, for it would then only require a lens of 25 cm. focal length = 4 D to correct the focus for parallel rays. The proper adjustment of correcting spectacles is therefore a matter of considerable importance (*see also* page 90).

Hypermetropia is of two kinds: (1) the *congenital*, and (2) the *acquired*.

Congenital H embraces the vast majority of cases, and in the higher degrees implies a shortening of the normal antero-posterior diameter of the eye, not infrequently accompanied by some flattening of the corneal curve. It is probable that very slight H, less than 1 D, is the *normal* if not constant condition of the refraction of new-born children. It may also in rare cases be due to congenital displacement of the lens. Congenital absence of the lens, if it ever occurs, is of extreme rarity.

Acquired H is produced by the removal or dislocation of the lens by operation or from injury, or it may result from the pressure of an orbital tumour upon the back of the globe, especially from a tumour connected with the optic nerve. It is also caused by the alteration in the normal refractive index of the lens which comes on with advancing years, and is due to chemical changes in the lens substance. Hypermetropia of this latter kind generally begins to show itself between the ages of fifty and sixty years, and from that time slowly advances, so that by the time eighty years of age is reached there is about 2 D of hypermetropia in a previously emmetropic eye. To the same extent original hypermetropia is increased and myopia diminished in old people.

Hypermetropia may be said to exist in two states: (a) the *manifest*, and (b) the *latent*.

Manifest hypermetropia is that degree of H which the patient exhibits when the accommodation has not been paralysed.

Latent hypermetropia is the further amount of H which is found after the paralysis of accommodation, and which was not manifest so long as the patient exerted his focussing power in looking at distant objects. It follows that the greater the power of accommodation the greater may be the amount of latent H. Thus in young subjects all

the H may be latent to the exclusion of the manifest; whilst in old subjects of seventy and upwards, there being practically no accommodative power, there can also be no latent H, which has become entirely manifest. To put the matter a little more clearly:—a child may be hypermetropic to a considerable degree, and yet by exerting his accommodation his vision may appear emmetropic when distant objects are viewed, and it is not until the accommodation has been paralysed that the true state of the case is made clear.

The sum of the manifest and latent hypermetropia is known as the “**total hypermetropia.**”

Frequency of Hypermetropia.—It is by far the most common visual defect. In a slight degree it is the normal condition in very young children. In an examination of the refraction of children over seven years of age attending London elementary schools held by the present writer in 1896, 872 cases of H occurred out of a total of 1065 cases of subnormal vision and 2014 children examined. This means that H is accountable for nearly 81 per cent. of all cases of visual error, and that we may expect to find it in about 44 per cent. of all children over seven years of age.

Ophthalmoscopic Phenomena.—By examination with the ophthalmoscopic mirror alone an erect image of the fundus can be seen at several inches from the eye, and, on the observer moving his head, the retinal vessels will be seen to travel in the same direction. The image will decrease in size as the observer retreats from the eye. By indirect examination, that is by aid of both the mirror and the object lens, an inverted image is seen, in which the optic nerve and vessels appear larger than in the normal eye. By direct examination an erect image of the fundus is obtained, in which the optic nerve and vessels appear abnormally small, the diminution in size corresponding to the amount of H present. The highest convex glass placed behind the sight-hole of the mirror through which a clear view of the fundus can be seen, will give an accurate measure of the degree of H (*see also* “*Ophthalmoscope,*” page 38).

Peculiarities of the Hypermetropic Eye.—These can only be noted in eyes with high degrees of H. *The eye is smaller in all its dimensions* than the normal eye, but especially in the antero-posterior axis, so that the globe has a flattened appearance. This can be distinctly seen if the patient is directed to look inwards as far as possible whilst the outer canthus is drawn outwards with one finger. It will then be noted that the curve of the eye over which the external rectus curls to its insertion is short and abrupt, and the globe looks flat and small for the orbit. *The cornea* is distinctly smaller than normal, and a definite flattening of the nose and upper portion of the face may often be remarked. *The anterior chamber* is frequently more shallow than in the normal eye. This is due to an enlarged ciliary muscle, which pushes the iris forwards, and which results from the constant use that the hypermetropic eye has to make of its accommodation. *Amblyopia*, or dulness of sight, is commonly seen in high degrees of H. The cause is doubtless to be found in the fact that such eyes are congenitally ill-developed.

Results of H.—The slight hypermetropia of early childhood often passes into emmetropia, and more rarely into myopia. Low degrees of H have no pathological significance, and only call for correction if, owing to general muscular depression from any cause, or from loss of accommodative power from advancing years, it is a source of discomfort to the patient. In the higher degrees of H we frequently encounter strong subjective and objective symptoms, due to overstrain on the part of the ciliary muscle. This condition is known as **accommodative or ciliary asthenopia**, to distinguish it from "*muscular asthenopia*," or fatigue of the internal recti muscles. The latter is also not very uncommon in hypermetropia, and when present is seen in company with accommodative asthenopia; but it occurs with far greater frequency in myopic patients (*see* "Heterophoria"). Accommodative asthenopia may take the form of cramp or spastic contraction of the ciliary muscle, which may be so severe as to mask the real trouble by rendering all the H latent, and even in some cases inducing a species of artificial myopia; or it may assume the ordinary characters of a fatigued muscle, so that the patient is unable to exert any accommodative effort. The subjective symptoms of accommodative asthenopia are manifested by inability to focus either distant or near objects for any length of time. Neuralgic headaches referred to the back of the eyes come on frequently after any prolonged use of the eyes. The general health suffers in consequence of the headaches, and anorexia, constipation, and anæmia are frequent sequelæ. Objectively, the eyes flush and water readily, the pupils, acting with the ciliary muscle, are contracted, and the patient objects to and shrinks from a strong light, which causes the pupils to contract still further. A chronic form of follicular conjunctivitis is very common, and is induced by the irritating effects of constant increased vascularity needed by the excessive use of the muscles of convergence and accommodation.

The *mental* results of high uncorrected hypermetropia are very important. The highly hypermetropic child is in a different position from other children. He cannot appreciate either distant or near objects with clearness or rapidity, and this inability produces consequent slowness in everything he does. A sleepy, languid manner is very common, whilst the child is generally dull in thought, and slow and backward in his lessons. This may be, and often is, partly due to a general intellectual deficiency, of which the hypermetropia is an outward sign of maldevelopment; but it is remarkable how often the correction of the H will improve the child's mental attitude. The deficiency above alluded to is not seen in myopic children, who are often exceptionally sharp, and in whom, moreover, the disadvantages entailed by their inability to see distant objects is in a great measure discounted by the exceptional acuity of their near vision. Another frequent result of H is **concomitant strabismus**. This most frequently takes the form of *convergent* strabismus, but in some cases *divergent* strabismus is the form assumed. Squint more commonly occurs in the slight and moderate than in the highest degrees of H, a peculiarity for which no entirely satisfactory reason is forthcoming. Lastly, H is undoubtedly a predisposing cause of glaucoma in later life.

Tests for H.—(1) *Subjective tests with test-types* (page 30).

(2) *Objective tests.*—(i) Ophthalmoscopy (page 38); (ii) retinoscopy (page 87).

Treatment.—This consists shortly in prescribing the convex lenses, which by sufficiently increasing the refraction correct the deficiency in this respect. As already pointed out (page 54), H of slight degree only calls for treatment under special circumstances, and in such cases the lens which corrects the manifest H, *i. e.* the highest convex lens with which the patient can read $\frac{6}{6}$ distinctly (page 30), should be ordered for near work, or added on to the lens required to correct existing presbyopia. Attention will be drawn to hypermetropic deficiency of high degree in comparatively early life, the time depending to a certain extent upon the general health and temperament of the patient.

As a *general* rule it is sufficient to prescribe the lenses that correct the manifest H in all cases where this correction gives perfect distant vision, and where there are no complaints indicative of asthenopia.

If the correction of the manifest H only *improves* the vision without rendering it normal, or if asthenopic symptoms are present, then the ciliary muscle should be paralysed by a few days' treatment with atropine (gr. iv ad $\frac{3}{j}$), and a search made for latent H and astigmatism by the ophthalmoscope or retinoscope. The correcting glasses should then neutralise the whole of the manifest and as much of the latent H as the surgeon may think fit, and in cases of astigmatism the glasses must, of course, include the correcting cylindrical lens.

Discretion is needed on the part of the surgeon in the correction of latent H. The most suitable glasses will generally be found to be those about 2 D less than the full correction under atropine, except in cases of strabismus, when it is advisable to correct to a rather fuller extent than this. Such glasses, although leaving the patient slightly hypermetropic (about 1 D), will be sufficient to remove all asthenopic symptoms. There is a routine practice among some surgeons of fully correcting all cases of H, founded upon the principle that the eye is thereby made emmetropic. This is correct in theory, but in practice it is wrong; for it must be remembered that nature has to a certain extent counterbalanced the defect of hypermetropia by providing an extra strong ciliary muscle, which although it may be unequal to the demands made upon it, still places the accommodative powers in H upon a different footing from that obtaining in emmetropia. Slight H has no pathological significance; and just as a patient with H less than 1 D would not be grateful under ordinary circumstances for the correction of his defect, so highly hypermetropic patients are much more comfortable when left slightly under-corrected, and a good deal of unnecessary pain and discomfort without any compensating advantages is thereby avoided.

When the H is of high degree, or asthenopic symptoms are present, the glasses should be ordered for constant wear. If there has been much latent H it is a good plan to let the patient first wear the

glasses while the eyes are still under the influence of atropine, so that he may become accustomed to their feel and weight, gradually experiencing their benefit as the power of accommodation slowly returns. If high convex lenses are suddenly forced upon the eyes whilst in a state of accommodative cramp the symptoms may be rendered worse for a time on account of the inability of the patient to control the spasmodic contractions of the ciliary muscle. High convex lenses are also very heavy, and in hot weather are very trying to a patient ; so if the latter be a young delicate child, it is often a good plan to prescribe for the first pair, lenses somewhat under the correction to be ultimately worn. In this way the child will take to the glasses kindly and without complaint.

CHAPTER V.

PRESBYOPIA (SYMBOL P).

PRESBYOPIA, or *Long Sight*, is one of the first of the legion of troubles which advancing years bring upon all of us. It consists in the recession of the near point, shown in the necessity of holding book or work further and further from the eyes. It is caused by gradual but constant decrease in the elasticity of the crystalline lens, which renders it less capable of altering its refraction in response to the calls of the ciliary muscle. This decrease commences in quite early life. Donders considered ten years to be the age of highest accommodative power, which begins to gradually decrease from that time. Presbyopia, however, is only said to have commenced when the near point has receded so far that the person is unable to carry on his work at a convenient distance.

Just as some people maintain their youthful vigour much longer than others, so this decrease in accommodative power takes place with varying rapidity in different people, and the onset of presbyopia is therefore subject to considerable variations in point of time.

Inefficient contraction of the ciliary muscle weakened by exhausting and debilitating illness, is, in some cases, responsible for a sudden increase or an early onset of presbyopia; but in healthy people a weak ciliary muscle cannot be held to be a factor in the causation of presbyopia, seeing that the recession of the near point has already commenced when bodily vigour is at its highest pitch.

Donders drew up the subjoined diagram, which shows at a glance the average amount of accommodation at any given age. He considered that presbyopia may be said to have commenced in an emmetrope when the near point had receded to a distance of 22 cm. from the eye. To view an object distinctly at this point requires 4.5 dioptries of accommodation, and reference to the diagram will show that this is the average limit of accommodation in an emmetrope of forty years of age. He will, therefore, from this time require some external aid in the form of a convex glass to increase his refraction and enable him to read and work at this distance (22 cm.).

The diagram may be accepted as fairly accurate with the reservation above given, and also bearing in mind that all people do not work at a common distance of 22 cm. (*Vide* "Treatment.")

If the eye be originally hypermetropic, the onset of presbyopia will take place at an earlier age than in an emmetropic eye, according to the amount of hypermetropia present. Thus, if a patient have $H = 3$ D he will, at the age of forty, according to the diagram below, be in the same condition as an emmetropic individual of fifty-five. That is to

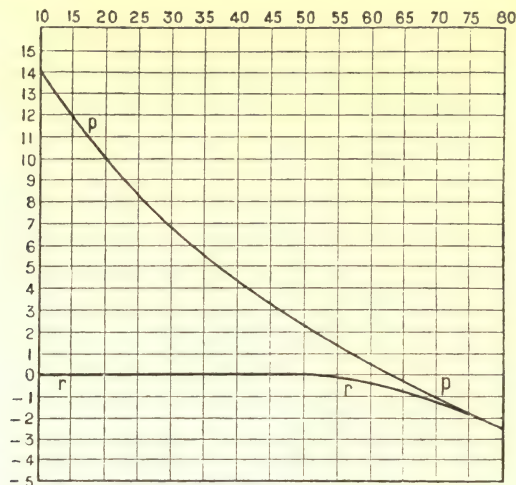


FIG. 45.—Chart showing the range of accommodation at various ages. (After Donders.)

The figures along the upper horizontal line represent the different ages, whilst those along the left perpendicular line show the number of dioptres of accommodation. The diagonal curve (*p p*) expresses the dynamic refraction or accommodative power of an emmetropic eye. This can be read off in dioptres for any age by noting the points at which (*p p*) intersects straight lines drawn from the vertical and horizontal margins. The line (*r r*) shows the static refraction of an emmetropic eye, *i.e.* the refraction of the eye at rest. It will be noted that it remains unchanged until the age of fifty-five, when it begins to decrease, the emmetropic eye becoming slightly hypermetropic. The two curves, (*r r*) and (*p p*), meet at the age of seventy-five years, illustrating that the eye at that age is incapable of any positive refractive change, its near point and far point being identical, and the eye being hypermetropic to the extent of about two dioptres. The decrease in the static refraction of the eye with advancing years is due to changes in the *constitution* of the lens, whereby its *static* refractive power is diminished. The myopic eye will therefore become less myopic and the hypermetropic eye more hypermetropic.

say that 3 D out of the 4.5 D of accommodation that he possesses at forty will be required for distant objects, leaving him only 1.5 D of accommodation for near work, which is the amount possessed by an emmetrope of fifty-five. However, it must be remembered that this is only partially true, as hypermetropic eyes have frequently hypertrophied ciliary muscles, and may be capable of much greater accommodative efforts than emmetropic eyes.

In myopia, on the other hand, presbyopia comes on later in life

than in emmetropia. Thus a myope of -3 D will be able to work easily until the age of fifty-five, when his near point will still be situated about 22 cm. from the eye. When the myopia amounts to -7 D or more it is evident that presbyopia will never occur.

Symptoms.—The usual complaint is that it is found necessary to have stronger light than formerly upon the work in order to see it distinctly; whilst fine work, such as threading a needle, is rendered difficult or impossible on account of the distance at which it must be held.

Treatment.—As presbyopia is not a disease, there is no call for its treatment until a patient becomes inconvenienced by its presence. At the same time it is an error to suppose that presbyopic patients should postpone the use of glasses as long as possible. By so doing they subject themselves to an amount of discomfort which could be avoided, without any compensating advantages for the sense of fatigue, heat, and occasional redness of the eyes which an over-strained effort of the accommodation induces.

The prescribing of suitable glasses in presbyopia often requires considerable judgment and experience on the part of the surgeon.

Many considerations must be weighed. Firstly, the static refraction of each eye must be ascertained, whether the patient be emmetropic, hypermetropic, or myopic; the amount of hypermetropia being added to, and the amount of myopia being subtracted from, the convex glasses that would be needed for an emmetrope. Secondly, the distance at which the patient is accustomed to read or work is of the highest importance. It has been already pointed out that 22 cm., or 9 inches, is by no means the invariable reading distance. Tall people with long arms hold their work as far off as 12 to 15 inches, whilst very short people, for a similar reason, often get closer than 9 inches. Such people would discard glasses that caused them to work at a distance to which they were unaccustomed. So, too, some kinds of occupation, such as watchmaking, require the work to be very near the eyes, whilst artists and musicians work at a comparatively long distance. Again, myopes who have been accustomed until late in life to hold their work close up to their eyes will not tolerate a glass that prevents their continuing the old habit. Thirdly, as already mentioned, it must be further remembered that the recession of the far point does not take place with equal rapidity in all people.

Thus every case of presbyopia must be judged on its individual merits, and the glasses prescribed, not according to any given rule, but according to the particular requirements of each patient.

When trying a patient for presbyopic glasses it will be noted that vision seems, up to a certain point, to be continuously improved the higher the convex glass we place in front of the eye. The book is held closer and closer to the eyes, and the glasses increasingly magnify the object, which is seen for the moment with great distinctness. Such glasses, if ordered, would make the eyes ache and would be soon discarded by the patient. *The weakest convex lens with which the patient can see clearly to do his work at his own distance is the right glass.*

It will also be often observed that people, instead of getting fresh

glasses when they feel the necessity for a stronger pair, instinctively push the glasses down the nose instead. This has the same effect as wearing a somewhat stronger glass; for if the position of the work be not altered the rays of light proceeding from the object, having their origin closer to the lens, are more divergent, and therefore brought to a focus further back. Moreover, such an arrangement allows the patient to look over his glasses when looking at distant objects, thus saving the trouble of constantly taking off and putting on the spectacles.

The time comes when a fresh pair of glasses are, however, needed in spite of all shifting. Such patients will frequently not again tolerate ordinary spectacles in the proper position on the nose close to the eyes, and the substitution of half-lenses which enable the patient to look over the glasses (*see* Fig. 59A) are very useful.

In fitting them, care should be taken that the upper rim lies no higher than the lower margin of the pupil when the patient looks straight ahead. Otherwise he will see the rims when looking at distant objects, and this will be a source of much discomfort.

The subjoined table, taken from Donders' diagram, will be found of general use, provided that it is employed merely as a guide and adapted to individual circumstances.

Table indicating the Amount of Presbyopia in the Emmetropic Eye.

Age.	Amount of Accomodative Power.		Lens required. Dioptries.	
45	...	3.5 D	...	1
50	...	2.5 D	...	2
55	...	1.5 D	...	3
60	...	0.5 D	...	4
65	...	0.25 D	...	4.5
70	...	—1 D	...	5.5
75	...	—1.75 D	...	6
80	...	—2.5 D	...	7

CHAPTER VI.

MYOPIA (SYMBOL M).

By myopia is indicated an increase in the static refraction of the eye whereby parallel rays of light, instead of being focussed upon the retina itself, meet at some point in front of the retina (Fig. 21, page 12), so that the latter only receives a blurred image of the object viewed.

Measurement of Myopia.—A myopic eye can therefore only focus divergent rays, or those emanating from an object nearer than twenty feet, and its far point of distinct vision (*punctum remotum* (R) Fig. 46) must be situated somewhere within this distance. The position of (R) will be a measure of the degree of M, and is most conveniently expressed by the value of the concave lens (L), which will render parallel rays (A B) so divergent that they will, if traced backwards, appear to spring from (R), and are consequently brought to a focus on

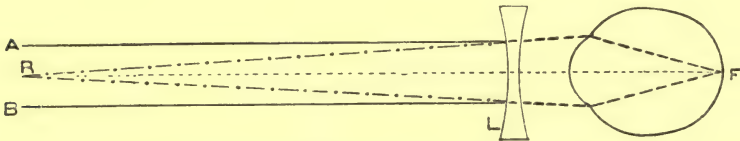


FIG. 46.—The measurement of M by a concave lens.

the retina at (F). It is evident that the principal focus of the lens (L) and (R) will coincide, and therefore if the value of the lens be -4 D, (R) is situated at 25 cm. from the eye and $M = 4$ D.

The position of the correcting lens with regard to the eye is important. Theoretically, it should touch the eye, for the further the lens is removed the less divergent will be the refracted rays when they reach the eye, and the more powerful must the lens be to produce the same effect. This is the opposite to what happens in moving a convex lens from a hypermetropic or emmetropic eye (*see* page 90). In practice the lens is placed about 1 cm. from the eye, and the slight alteration thus effected in the accuracy of the measurement of M is not taken into account; but the case is otherwise if spectacles are allowed

to slip about anywhere on the nose, and the proper adjustment of lenses is therefore a matter of some practical importance.

Myopia may be due to—(1) increase in size of the posterior segment of the globe (*i.e.* the part behind the lens), chiefly expressed by a lengthening of the antero-posterior diameter of the eye. This is known as *axial or typical myopia*. (2) Some alteration in the media of the eye whereby the refraction is increased.

I. Axial Myopia.—**Ætiology.**—Axial myopia embraces the vast majority of cases. It is probably never congenital, but it may commence at a very early period of life. It generally comes on insidiously during the educational age, between four years and sixteen years, most commonly about the period of adolescence when education is being pushed on and growth is most rapid. There is a strong hereditary predisposition in myopia, and it may often be traced through several successive generations in a family, or, as in Germany, it may become a racial characteristic. Both sexes are equally liable to be affected. It is essentially an affection of civilisation and education, as savage races are almost, if not completely, exempt, as are also all varieties of lower animal life.

No direct cause can be assigned for the onset of myopia, but there are certain predisposing causes besides the hereditary tendency to which allusion has just been made, to which considerable importance must be attached, although we are not altogether certain of their precise mode of influence. Too long hours of lessons, especially when the books are badly printed or of very small type; faulty positions when at work, such as resting the head on the table or stooping closely over the book so as to employ an undue amount of convergence and accommodation, are undoubted factors, and it is a commonly noted fact that myopia is especially frequent in the more precocious and clever members of a family who are devoted to reading and study. It is true that the powers of accommodation and convergence reach their highest limit in early youth, and at first sight it would appear strange that children cannot employ these functions with the immunity of adult life; but it is the very excess of power which does the mischief. If left to himself a child will, as a rule, bring his work quite close to his eyes, so as to gain as large retinal images as possible, and on account of his superabundant power he will maintain an excessive and quite unnecessary convergence and accommodation without feeling the strain or aching which would quickly follow in the case of an adult.

Opinions differ as to the mode by which excessive accommodation and convergence act injuriously. Some hold that the intra-ocular pressure is raised during accommodation, and that the recti muscles exercise lateral pressure on the globe, so that there then exists a tendency for an antero-posterior expansion of the eye. Others think that in extreme convergence the posterior pole of the eye, being rotated outwards, is pulled upon by the optic nerve; and others, again, that the pressure of the oblique muscles during long and sustained convergence may interrupt the proper flow of blood through the *venæ vorticosæ*, and thus induce a congestion of the globe. Whatever be the exact cause, there can be no doubt that the increased vascularity demanded by

prolonged muscular effort favours an actual expansion of the ocular coats, which is readily obtained in the soft yielding tissues of childhood. That this expansion, though affecting all diameters of the globe, is more especially manifested by an increase in its antero-posterior axis is perhaps best explained by the lack of a posterior support to the globe equivalent to that effected laterally by the recti muscles; whilst to the toughness and resistance of the cornea, and to the extra support given by the tendinous insertions of the ocular muscles, may be ascribed the reason why this expansion is limited to the segment of the globe that lies behind the lens.

A defective condition of the general health, or of the eye itself, may also influence the onset of myopia. It is about the age of puberty, the most common time for myopia to make its appearance, that children are very liable to outgrow their strength, and we have seen a fair number of cases of high myopia in children who were affected with choroidal disease, the result of inherited syphilis.

II. Under the head of *myopia due to alteration in the refractive media of the eye* can be classed many conditions of the cornea and lens, some pathological and some physiological. In conical cornea the corneal refraction is greatly increased, as also in the bulging of the cornea after long-continued inflammatory processes. Faint nebulae, the results of superficial wounds or ulcers, will produce the same effect. In incipient cataract and in old people the lens fibres undergo changes which increase their refraction, whilst spasm of the accommodation may also induce a species of artificial myopia.

All these changes in the refractive media will be found discussed elsewhere, and the subjoined remarks will only apply to the first great class of myopia, that of axial myopia.

Clinical Varieties of Axial Myopia.—The disease assumes two distinct types.

a. Simple Myopia.—Characterised by slowly increasing refraction, which gradually becomes stationary after the completion of growth, and which is unaccompanied by destructive changes in the fundus.

b. Malignant Myopia.—This variety usually commences at an earlier age than simple myopia, and is characterised by rapid progress and destructive changes in the fundus and elsewhere, which may ultimately cause complete blindness.

It must be remembered that no hard-and-fast rules separate simple from malignant myopia. They are only different types of the same disease, and a case which at first assumes the characteristics of simple myopia may drift, if unchecked, into the malignant type of the disease. Simple myopia fortunately includes by far the larger number of cases, but malignant myopia is far from rare. The age at which myopia first makes its appearance has great influence on the type assumed. The younger the patient the greater the probability of the myopia running a markedly progressive and destructive course.

Frequency of Myopia.—In London, myopia occurs in about 5 per cent. of all children under fourteen years of age, and in about 8 per cent. of all forms of refractive error. This percentage is calculated from an examination by the writer of 2000 London school children,

and tallies very nearly with that found by other observers. In rural districts the percentage would probably be smaller. Fuchs estimates that 60 per cent. of the pupils in the highest classes of German high schools are myopic.

Symptoms of Myopia.—Whilst distant objects are not viewed with clearness, near objects, such as books, etc., are viewed with exceptional acuity, because retinal images in myopia are somewhat larger than in emmetropia (*vide* p. 13). As the near point in myopia is much closer to the eyes than in emmetropia or hypermetropia, the onset of presbyopia is correspondingly late, and in high degrees of myopia never makes its appearance at all.

The highly myopic eye is larger than normal, and may project somewhat between the lids. Myopic patients are apt to develop a

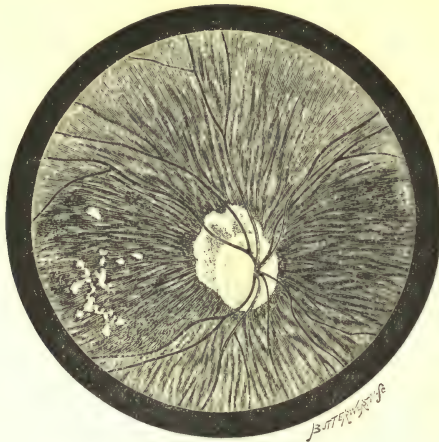


FIG. 47.—Ophthalmoscopic appearance of the fundus in a case of progressive myopia. The myopic crescent is irregular, seamed, and blotched with pigment, and the nerve-head is considerably tilted. Round the macula there is much proliferation of pigment, with irregular patches of choroidal atrophy. This and the next figure should be compared. (*See also* Text.)

permanent stoop in early life from constant approximation of the book, etc., to the eyes. A constant slight frown is also very typical, and is due to instinctive partial closure of the lids so as to diminish the palpebral aperture when looking at distant objects. By this means many of the peripheral rays of light are cut off, and, by limiting the circles of diffusion, a clearer image is obtained. The anterior chamber is rather deeper than in emmetropia, and the pupil often larger on account of the small size of the ciliary muscle and the complete relaxation of accommodation.

Ophthalmoscopic Phenomena in Myopia.—By examination with the ophthalmoscopic mirror alone, an inverted image of the fundus may be seen at some inches from the eye, and if the observer moves his head the retinal vessels will appear to travel in the opposite direction. The image becomes larger as the observer retreats from the eye.

By *indirect examination with the object lens*, an inverted image of the fundus is obtained which appears rather smaller than in an emmetropic eye.

To obtain a clear view by *direct examination*, the observer must approach very near to the patient's eye and place a concave lens, equivalent to the degree of myopia, behind the mirror. For, as the retina is beyond the focus for parallel rays, such a concave lens is needed as will transfer the focus to the retina before anything can be seen. The observer must completely relax his accommodation, or an unnecessarily high concave lens will be required. The lowest lens thus required will give the degree of myopia. The image formed is very highly magnified and erect (*see also "Ophthalmoscope"*).

The most characteristic evidence of myopia consists in the presence



FIG. 48.—Another variety of fundus in progressive myopia, which should be compared with the preceding figure. The myopic crescent is large, but regular in outline, and there is a very large physiological cup. Around the disc there is much general thinning of the choroid, exposing the deep choroidal vessels and white sclerotic. Round the macula the atrophy of the choroid is exhibited in discrete punched-out patches, many of the more external ones being surrounded by healthy tissue. This latter variety of choroidal atrophy is much rarer than that depicted in Fig. 47. (*See also Text.*)

of a small white band, known as the *myopic crescent*, or *posterior staphyloma*, which is generally situated on the outer side of the optic nerve. It is caused by the prolongation or bulging backwards of the choroid and sclerotic at this point, with the result that the choroid atrophies and allows the shining white sclera to become visible. Its appearance, position, and size are exceedingly variable. It may appear characteristically crescent-shaped, with smooth, regular outline (as in Fig. 48), or as an irregular patch, with a scarred and fissured border (as represented in Fig. 47). It may lie above or below, as well as on the outer side of the nerve; in rare cases it is entirely on the inner side, and in high myopia it not infrequently completely surrounds the nerve. In size it may be a mere slip, or in very severe cases it may extend almost to the macula. As a rule, large and irregularly shaped crescents are

accompanied by other evidences of choroidal disease, and may be said to be characteristic of the higher and most progressive cases. The papilla frequently appears elongated, owing to some tilting of the nerve, so that a perfect full-face view of it is not obtained; and when this is the case the vessels, for the same reason, appear somewhat displaced to its inner side.

The Sequelæ and Complications of Myopia.—In the progressive type of myopia, the macula and its immediate neighbourhood are frequently the scene of distinctive changes, characterised by their asthenic type and being processes of degeneration rather than of inflammation. The ophthalmoscopical appearances vary largely in detail in different cases. In some no circumscribed lesion is seen, but the choroid is stretched and thinned over the central area, and the wasting of its pigment exposes the pink ribbon-shaped choroidal vessels coursing over a glistening white background formed by the subjacent sclerotic (see Fig. 48). In others this condition is varied or replaced by circumscribed buff-coloured patches of partial atrophy of the choroid, or by irregular white plaques frequently lined or mottled with blotches of proliferated pigment, and from which the absence of blood-vessels shows that the choroid is here completely destroyed (see Fig. 47). In others, again, the choroid shows here and there a linear splitting of its coats, which gives it a scarred or seamed appearance. The participation of the retina in these changes is exhibited by the frequent appearance of retinal hæmorrhages and by the loss of central vision, often very great, that follows the stretching and consequent atrophy of its nerve-fibres. In the worst class of cases the nutrition of the vitreous and lens becomes impaired. The former loses its transparency, floating opacities, the result of atrophic changes or minute particles of blood-clot, appear in it, liquefaction follows, and sometimes shrinkage. In the lens, opacities appear first at its posterior pole, and may gradually spread throughout its substance until it becomes completely cataractous. In many cases complete destruction of sight is caused before these later stages are reached by a sudden detachment of the retina, which, unable to follow the expansion of the choroid, or from loss of the normal support afforded by the vitreous, is easily displaced by some physical exertion or some other cause that produces a temporary congestion of its blood-channels.

A special form of congestion of the macula, usually only seen in children, is worth noting. It consists in a peculiar red staring condition of the fundus at this spot, and in the reflection from the fovea of a brilliant triangular pencil of rays resembling the flash from a bull's-eye lantern, whence the condition is often called *bull's-eye macula*.

A rare form of choroidal atrophy in myopia is that pictured in Fig. 48, and is characterised by the discrete and punched-out appearance of the diseased areas.

Disturbances in the reflex acts of accommodation and convergence are very common in both the simple and progressive types of myopia. As already pointed out on page 19, a standard effort of accommodation is, in emmetropia, associated with a standard degree of convergence;

but in myopia some dissociation of this relationship is needed on account of the approximation of the far point, which renders it necessary that convergence should exceed, or in high degrees of M should be carried on without accommodation. Many patients, with the gradual onset of M, learn to adapt themselves to their requirements; but others, and especially young children who are affected with rapidly increasing myopia, become troubled with *spasm of the accommodation*, which is evidenced by the appearance of aching eyes, headache, flushing and watering of the eyes, and photophobia. So, too, the converging power is frequently unable to meet the demands made upon it, and gives way, with the result that subjective symptoms of headache, etc., such as are encountered in spasm of the accommodation, arise, together with the objective signs that indicate insufficiency of the internal recti, or muscular asthenopia (*see also* "Heterophoria"). The two conditions of spasm and insufficiency often go together, and not infrequently lead to loss of binocular vision, and in some cases to strabismus, usually of the divergent variety.

In addition to these local complications, the general health in young children often suffers materially from the aching and general discomfort they experience, and in this way a vicious circle may be established, which favours a rapid advance of the disease.

Tests for Myopia.—*Subjective tests* by test-types (*vide* p. 28).

Objective tests: (a) Ophthalmoscope (*vide* p. 38); (b) Retinoscopy (*vide* p. 88).

Prognosis.—This varies with the type assumed. Simple myopia is only dangerous as long as there is any chance of its drifting into the progressive type. Such a danger is always possible, but highly improbable after growth has ceased. The younger the age at which myopia first makes its appearance the more serious the prognosis, especially when its onset has been favoured by constitutional conditions, such as congenital syphilis.

Treatment of Myopia.—This is of the greatest importance, for although myopia can never be removed, still very much may be done to check its progress and minimise its dangers.

The treatment may be divided into three parts:

1. *Treatment by Glasses.*

2. *General Treatment*: (a) as regards work, and (b) as regards the management of malignant cases.

3. *Operative Treatment.*

1. **Treatment by Correcting Glasses.**—*Distance Glasses.*—The exact amount of myopia must be determined by subjective test with Snellen's test-types, aided, if necessary, by the ophthalmoscope and retinoscopy. The *lowest* concave lens that gives $\frac{6}{6}$ vision is the measure of the myopia, and may be ordered for distant vision.

If no spherical glass will bring the vision to $\frac{6}{6}$, search must be made for opacities in the media, fundus changes, or astigmatism. If either of the two former are found and the history is one of rapid or recent failure of sight, or if the patient is young, the question of glasses should be abandoned for the time, and a course of treatment on the lines laid down for malignant cases on p. 69 should be prescribed. If,

on the other hand, astigmatism alone is found, its degree must be accurately determined, and the correcting cylinder combined with the sphere, as described in dealing with astigmatism (p. 74). Even in this case it will often be found that the vision cannot be raised above $\frac{6}{9}$ when more than a moderate degree of M is present. Many patients are unable to wear the glasses that fully correct the refraction on account of the dazzling and dragging feeling that they produce, and when this is so the only course to pursue is to sacrifice some visual acuity for the sake of comfort, and to order glasses about -1 D less than the full correction, lightly tinting them with a neutral shade for outdoor wear. The constant wearing of glasses is necessary in the high degrees of M, because the far point is so near the eye that the patient cannot get through the ordinary duties of life without some continual aid; but in the lower degrees, up to about -4 D, and this is especially the case in children, the constant use of glasses is, in our opinion, to be discouraged. The reason is that myopes have a tendency to speedily become entirely dependent upon their glasses, and to lose much of their power of recognising surrounding objects by their general appearance, etc., a faculty that many myopes possess to an extraordinary degree, though they cannot perceive details. Complete reliance on glasses has its obvious drawbacks, and in young people the constant wearing of glasses is, in addition, a real source of danger; so that while distance glasses, to be worn whenever detailed sight is required, may be prescribed, still it is a good plan to encourage these patients not to use them when such vision is not required, as in the house, etc.; and in this way children will often be enabled to indulge in games without glasses, and so without danger, which the absence of glasses, if they had been worn for long, would prohibit them from doing.

Reading Glasses.—Myopes of -3 D or less do not require reading glasses, as they can, up to the age of about fifty-five, read the finest diamond type at a good working distance of 33 cm. ($\frac{100}{3} = 33$). In higher degrees than this, reading is only carried out by unduly converging, and therefore reading glasses are ordered which will enable the work to be performed at a reasonable distance. These will be found to be about -2 D less than the full correction for distance; but the good effects of reading glasses are considerably stultified as myopia increases, because of the diminishing effect of concave lenses, which increases with their dioptric strength and causes the patient to bring the work nearer to the eyes than he otherwise need do to counteract this defect. In very high degrees of myopia the retinal images are rendered so small by the correcting lenses that reading glasses become useless, and the patient is far happier and more comfortable without them; and in such cases we must rest content with restricting the work, and confining it, as far as possible, to that which is well printed and of large type.

In children two pairs of glasses are undesirable, so that if the degree of M necessitates the constant wearing of glasses, one pair suitable for work should be ordered for all purposes; and these will give sufficiently good distant vision. In small degrees of M, when the

chief complaint is the difficulty in seeing the blackboard, a pair of spectacles rather under the full correction may be ordered to be worn during school hours, the child being placed as near the blackboard as possible, and with his ample accommodative power he will be able to work with these without any effort.

In some cases of extreme M the patient cannot bear the wearing of glasses sufficiently strong to be of any material service to him, and for these a *Steinheil's cone* is sometimes of service. This consists, practically, of a small portable opera-glass,—that is to say, of a convex lens placed within the focal distance of a high concave lens, which forms the eye-piece. This can be carried in the waistcoat pocket and put up to the eye whenever clear sight is wanted.

General Treatment.—A few general directions should be given to all myopic patients, but general treatment is of especial importance in the malignant class of cases.

General directions to *all* myopic patients:

1. The patient should always work with a sloping desk, so that the work is brought up to the eyes, and not the eyes lowered to the work. In this way rounding of the shoulders is avoided in the young. Moreover, stooping tends towards congestion of the eyes and headache.

2. The work should be kept as far away from the eyes as is consistent with comfort. This is a very important point for parents to notice with children, who, even when they are emmetropic, are apt to bring the book much too close to the eyes, and may thus possibly induce myopia.

3. The light upon the work should be good. Bad light involves the necessity for bringing the eyes closer to the work than is otherwise needful. If work is done by artificial light, shaded candles, or a good reading-lamp throwing the light directly upon the work, are the best media. The rest of the room may be in comparative darkness.

4. Proper attention must be paid to ventilation and, in schools, to a sufficient amount of cubic space per child.

Special Treatment of Malignant Myopia:

1. *Eyes.*—Complete rest for the eyes is imperative in cases where (a) fundus changes are seen hand-in-hand with such symptoms as photophobia, blinking, conjunctival congestion, and ciliary spasm; and (b) all cases of high myopia in very young children, even if subjective symptoms are not marked or absent. This rest can only be obtained by stopping the child's education for a time, and by paralysing the accommodation with atropine, a weak solution of which (grs. ij ad ʒj) may be dropped into the conjunctival sac every night and morning. It is a good practice to order neutral-tinted protectors for use outdoors, and if subjective symptoms are marked great comfort will be derived from them. The length of time that this treatment should be maintained must rest with the discretion and experience of the surgeon, but it should not be discontinued whilst any of the above symptoms are present. As a rule, at least six months are required, and often longer. At the end of this treatment the patient's sight will usually be found markedly improved, and he may be ordered

concave glasses — 2 D to — 3 D less than the full correction for constant wear, with restrictions as to hours of work, etc.

In less markedly progressive cases the atropine treatment may be discarded or considerably shortened or modified, but the case should be carefully watched, and treated on the general lines, as to work, etc., already enumerated, with special attention to the general health as given below.

2. *General*.—This is almost as important as the treatment of the eyes. It simply consists in paying more than usual attention to the ordinary rules of health. Children should have plenty of bed-rest and plenty of healthy exercise, and the daily action of the bowels regularly maintained. Some form of tonic treatment should be prescribed, and in children there is nothing better than cod-liver oil combined with malt extract, as in the well-known Kepler's preparation. Some surgeons strongly advocate arsenic, and we have found it a very useful drug in some cases.

3. *Operative Treatment*.—This consists in the removal of the crystalline lens. The relief of the extreme disabilities of highly myopic patients by this measure is a suggestion of very long standing, but it received very little favourable support until it was once more brought into prominent notice by Fukala in 1890. Since that date some thousands of cases have been submitted to extraction of the lens, with, on the whole, very good results. The form of operation most generally employed, and the one undoubtedly involving the least risk, is a dissection of the lens, followed within a few days by a simple linear extraction, as carried out for the removal of a lamellar cataract (*see* "Lens").

The treatment is not one to be undertaken recklessly, and the cases suitable for it must be carefully chosen. In the first place, it is only to be desired in extreme cases of M, when glasses fail to give sufficient central vision to enable the patient to carry out the ordinary avocations of his daily life; and this primary consideration may be said to be generally fulfilled in myopes of —14 D and over. The patient should be young, certainly not over 40 years, and preferably under 25 years of age. The presence of vitreous changes or severe central choroidal trouble is a strong disqualification, for they would discount any material improvement in vision, and the ordinary risks of operation would be increased. The latter, though small in well-selected cases, must, as in recommending any intra-ocular operation, be borne in mind, and in addition there is some risk of failure by detachment of the retina, or by an intra-ocular hæmorrhage, though in view of the fact that extreme myopia is always subject to these accidents, it is at present doubtful to what extent the treatment itself is to be held responsible in increasing the risk of their occurrence.

The improvement obtained in central vision after removal of the lens is in the majority of cases exceedingly satisfactory, and is no doubt largely due to the increased size of the retinal images. The loss in the refraction of the eye is very great, much greater than that following the removal of the lens in emmetropic or hypermetropic eyes. In the latter the static refraction of the lens is regarded as + 10 D, and a convex

lens of this value is sufficient to neutralise the effects of extraction of the lens as far as distant vision is concerned. We should expect, therefore, that when $M = 10\text{ D}$ removal of the lens would render the patient emmetropic; but as a matter of fact, owing to the increased length of the posterior segment of the globe—for there is no proof that the radius of curvature of the cornea or the dioptric value of the lens is altered in M ,—the ordinary formulæ are upset, and emmetropia is not usually reached unless the previous degree of M amounts to about 20 D . The exact effect of extraction cannot, however, be accurately gauged, for results differ within very large limits, but the presence of 20 D of M may be taken as probably indicating that no glasses will be required for distant vision. A patient rendered emmetropic in this way would require convex lenses of $+6\text{ D}$ for reading purposes, so that perhaps the result most to be desired is a myopia of 2 D or 3 D remaining after operation, in which case the patient could dispense with reading glasses, and have very fair distant vision without distance glasses as well.

There are a few minor points which must be decided by the judgment and experience of the surgeon. Thus few would care to operate if the patient had lost one eye, or to risk operation on the second eye if detachment of the retina or other serious accident had followed operation upon the first. Under any circumstances the advisability of operating on both eyes must depend upon the merits of each individual case, because, for example, it may be found after operation on one eye that the patient gets on best with the unoperated eye for near vision, whilst the aphakic eye is used for distant sight.

CHAPTER VII.

ASTIGMATISM (SYMBOL As)

AND

ANISOMETRIA.

By Astigmatism is meant an inequality in the refracting media of the eye, so that rays of light are not all brought to a common focus upon the retina, and the resultant image is therefore blurred.

Astigmatism is of two kinds, (1) *regular* and (2) *irregular*.

REGULAR ASTIGMATISM.—This variety, which alone is amenable to optical correction, is chiefly due to asymmetry in the corneal curves, though in some cases irregularity in the lens surface may play a certain part in the causation. This asymmetry lies in two chief planes, which are known as the *principal meridians*, and always lie at right angles to each other, the one being the plane of highest refraction and the other the plane of lowest refraction. The refractive value of all other planes will be regularly intermediate in nature according to their position with regard to the principal meridians. The principal meridians most usually lie in a vertical and horizontal plane, of which the vertical is commonly the plane of highest refraction; but they may lie in any degree of obliquity, though always maintaining a position at right angles to each other. *The difference between the refraction of the two principal meridians is a measure of the degree of astigmatism.*

Regular astigmatism may be congenital or acquired. Very slight As is excessively common, possibly universal, but when of less degree than 0.5 D very rarely calls for optical correction. Acquired As arises from perforating wounds of the cornea, such as those resulting from iridectomy or the extraction of cataract, or it may develop in an originally hypermetropic or emmetropic eye in the process of elongation due to the onset of myopia. In the latter case the degree of As is liable to alter with the progress of the disease. It may be present in one or both eyes, and may differ in kind and degree in each eye.

Regular astigmatism may be also (a) *simple*, (b) *compound*, or (c) *mixed*.

In (a) **simple astigmatism** one principal meridian is emmetropic, whilst the other is hypermetropic or myopic. Thus, if the emmetropic meridian be represented by 0, whilst in the other meridian $H = 1.5\text{ D}$, there will be Simple H As = 1.5 D.

In (b) **compound astigmatism** the principal meridians are either both hypermetropic or both myopic, but the defect in one meridian is

greater than that in the other. For example, if the case be one of compound myopic astigmatism where the refraction in the vertical plane = -4 D, and that in the horizontal plane = -2 D, there will be Compound M As = 2 D.

In (c) **mixed astigmatism** one principal meridian, usually the horizontal, is hypermetropic, and the other, usually the vertical, is myopic. For example, supposing the refraction of the vertical meridian to be $M = -2$ D, and that of the horizontal to be $H = +2$ D, the difference between the two meridians is here found by algebraical rule in the addition of the two figures, and there will be therefore Mixed As = 4 D.

The Correction of Astigmatism.—As is corrected by means of cylindrical glasses, which possess the property of only refracting those rays of light which pass through at right angles to the plane of the long axis of the cylinder (*vide* page 7). Thus, if a cylinder be placed with its long axis vertical, all horizontal rays will be refracted, but none of the vertical rays; so that if a cylinder of an equivalent dioptric strength to the algebraical difference between the two principal corneal meridians be placed so as to exert its refractive power in the plane of the meridian of more faulty refraction—that is, with its long axis at right angles to this meridian—it must, as a consequence, level the refraction of the two meridians, or, in other words, it must correct the astigmatism. This method of employing cylinders will be further considered in describing the various tests which are used to estimate corneal astigmatism.

The Diagnosis of Astigmatism.—Whenever examination with Snellen's test-types reveals a subnormal standard of vision which cannot be improved by spherical lenses, and for which there is no external or internal evidence of past or present disease, astigmatism is to be suspected as the most likely cause. The diagnosis is confirmed by several means, most of which can at the same time be employed to measure its degree, and the matter is therefore best considered in describing the estimation of astigmatism.

The Estimation of Astigmatism.—This is carried out by objective and subjective tests. *Objective tests* are the most accurate, and upon these the student should learn to chiefly depend. They are four in number, *viz.* (1) retinoscopy, (2) the ophthalmoscope, (3) the astigmometer, (4) the keratoscope. Of these only the first two furnish us with the complete knowledge required to correct the astigmatism,—that is, they measure the refraction in each of the principal corneal meridians, by means of which the diagnosis is confirmed and the degree of astigmatism is estimated. To retinoscopy preference must be given over the ophthalmoscope as being easier, more accurate, and therefore more reliable, and it is the method now almost universally adopted in all difficult and important cases. The astigmometer diagnoses astigmatism and furnishes us with its degree, but does not estimate the refraction; whilst the keratoscope merely provides evidence of astigmatism, and is therefore only diagnostic.

Subjective tests have only a limited practical value. They are useful to diagnose astigmatism and to eliminate small degrees, most particularly when the astigmatism is of the simple type; but when it is

compound or mixed, retinoscopy is far preferable. They consist in (1) estimation by the stenopæic slit and (2) estimation by the astigmatic clock-face.

OBJECTIVE TESTS for astigmatism :

1. **Retinoscopy.**—We must suppose that the refraction of each corneal meridian has been worked out independently after the manner described in the chapter on retinoscopy, and that astigmatism is found. The result should be noted down on cross-lines and, when possible, checked afterwards by the use of test-types, as recommended in that chapter.

The correction of the astigmatism will be rendered easy by a few rules and examples of the various types of astigmatism.

Rule 1.—The algebraical difference between the refraction of the corneal meridians always represents the strength of the correcting cylinder.

Rule 2.—The cylinder should be placed with its long axis at right angles to the meridian of more faulty refraction. This rule is constant in simple and compound astigmatism, and is generally to be followed in mixed astigmatism, but will be referred to again in giving examples of this defect.

Rule 3.—In compound and mixed astigmatism a spherical lens is required in addition to the cylinder. In compound astigmatism this is always used to correct the meridian of less ametropia. In mixed astigmatism it is generally a good plan to follow the same rule (*vide* examples).

Simple Astigmatism (Example A)—
+ 1 D

Found by retinoscopy ———— + 3 D, which, according to the

| Emmetropic

rule for the reversal of shadows, is equivalent to ———— + 2 D.

Here $As = 2$ D, and the required correcting glass will be Cyl. + 2 D axis vert.

Compound Astigmatism (Example B)—
- 5 D

Found by retinoscopy ———— - 2 D, which, according to rule,

- 6 D

is equivalent to ———— - 3 D.

Here $As = 3\text{ D}$. A spherical lens of -3 D is required to correct the horizontal meridian, and will at the same time correct 3 D of the vertical myopia, the remaining 3 D being corrected by the cylinder.

The correcting glass will therefore be $Sph. - 3\text{ D} \bigcirc cyl. - 3\text{ D axis hor.}$; or it may be written $\frac{Sph. - 3\text{ D}}{Cyl. - 3\text{ D axis hor.}}$. This will give the best vision for distance, but for reading -2 D should be deducted from the spherical lens, as recommended in myopia (page 68), and the spherical will require to be still further reduced as the near point recedes with advancing age.

Example C.—Supposing we have to deal with a similar amount of compound astigmatism in a *hypermetropic* patient, it will probably be necessary, to get the best vision, to deduct more than $+1\text{ D}$ from the refraction as obtained by retinoscopy. This extra amount will vary from $+0.5\text{ D}$ to $+1\text{ D}$, and, as explained in the chapter on "Retinoscopy," allows for the normal tone of the ciliary muscle, which is often hypertrophied in hypermetropia.

The glasses that would probably give best vision in this case would be $Sph. + 0.5\text{ D} \bigcirc cyl. + 3\text{ D axis hor.}$; or $\frac{Sph. + 0.5\text{ D}}{Cyl. + 3\text{ D axis hor.}}$.

This latter would also be an example of astigmatism *against the rule*, the meridian of higher refraction being the horizontal.

Example D.—Low degrees of *compound myopic astigmatism* exhibit a little peculiarity in treatment.

Found by retinoscopy of right eye

-0.5 D $+0.25\text{ D}$
axis 45° up and in,

which is equivalent to -1.5 D -0.75 D
axis 45° up and in.

Here $As = 0.75\text{ D}$, and the correction will be

$Sph. - 0.75\text{ D} \bigcirc cyl. - 0.75\text{ D axis } 45^\circ \text{ up and in.}$

With such a glass the best vision will be obtained for distance. For reading, up to the age of forty or thereabouts, the patient will be most comfortable with the simple cylindrical correction, which allows him a myopia of -0.75 D in every direction, and we should therefore order him $Cyl. - 0.75\text{ D axis } 45^\circ \text{ up and in.}$ As the near point begins to recede, however, the higher degree of myopia in the one meridian (-1.5 D) becomes an advantage to him, as it gives him greater refractive power, and consequently he will be more comfortable if we order him $Cyl. + 0.75\text{ D axis } 45^\circ \text{ up and out,}$ which will

increase the meridian of lower refraction to -1.5 D, and make him myopic to that extent in every direction.

In still later life he will eventually require a weak $+$ spherical lens in addition, so that we may order, for example—

Sph. $+1$ D \subset Cyl. $+0.75$ D axis 45° \ up and out.

Mixed Astigmatism (Example E) :

-4 D

Found by retinoscopy ———— $+2$ D, which is equivalent to

$\begin{array}{c} | \\ -5\text{ D} \\ | \\ \hline \\ \hline \\ | \\ +1\text{ D} \\ | \end{array}$

Here the As, by algebraical rule, amounts to 6 D.

Two corrections are permissible :

(1) Sph. $+1$ D \subset Cyl. -6 D axis hor.; or $\frac{\text{Sph.} + 1\text{ D}}{\text{Cyl.} - 6\text{ D axis hor.}}$

(2) Sph. -5 D \subset Cyl. $+6$ D axis vert.; or $\frac{\text{Sph.} - 5\text{ D}}{\text{Cyl.} + 6\text{ D axis vert.}}$

The first method of correction is better for two reasons. It follows the rule of correcting the less ametropic meridian with the sphere, and the resulting lens is not so heavy as the one ground according to the second correction. Secondly, concave cylinders, as a matter of experience, are more comfortable for constant wear than convex, and certainly give better results for distant vision. When the glasses, however, are prescribed for work alone, convex cylinders are often preferred by the patient to concave, so that no hard-and-fast rule can be laid down, but the surgeon must use his own judgment, aided by the principles above enumerated.

A third correction may be mentioned, applicable to both compound and mixed astigmatism, but it is not to be recommended, as the lens is difficult to grind and much more expensive. It consists in correcting each meridian with a cylinder, and would read thus :

Cyl. $+1$ D axis vert. \subset Cyl. -5 D axis hor.; or
Cyl. $+1$ D axis hor.

Cyl. $+5$ D axis vert.

2. **The Ophthalmoscope.**—By direct examination the disc appears oval, with its long axis in the direction of the meridian of highest refraction, which is usually the vertical. If the astigmatism is considerable it produces a slight general blurring of details, which may be mistaken by the unwary or inexperienced for organic disease. By indirect examination the disc will appear to be elongated in the direction of the meridian of least refraction, usually the horizontal, provided

that the object lens is not approached nearer to the eye than its own focal length.

To measure the degree of astigmatism, the direct method of examination is employed. Two retinal vessels are selected, one travelling in a vertical direction and one horizontally. The dioptric difference between the two lenses required to see the two vessels distinctly will be the measure of the astigmatism. As in all examinations with the direct method, the surgeon must relax his own accommodation and allow for any ametropia he possesses. The result obtained should be noted down in the same way as after retinoscopy, checked by the use of test-types, and correcting glasses ordered in a precisely similar way, remembering only that there is no need to make any allowance, as is necessary after retinoscopy, for the reversal of the shadows. In compound hypermetropic astigmatism, however, some reduction ($+0.5$ D to $+1$ D) will probably have to be made in the correcting *spherical* lens, to allow for the normal *tone* of the ciliary muscle, if atropine has been used to paralyse the accommodation.

3. The Astigmometer.—This is an instrument for estimating the presence and degree of *corneal* astigmatism. It does not record the actual nature of the refraction in each meridian, and so it is chiefly useful as a subsidiary test or check to retinoscopy and the use of test-types, etc. The astigmometer in most general use is that devised by Javal and Schiötz, and the following is a short description of an excellent modification of this instrument introduced by Kagenaar, of Utrecht, and in use at the Royal London Ophthalmic Hospital.

It consists of a telescope (*p*) containing a doubly refracting prism between the object-glasses, and a metal arc (*m*) which can be revolved on its own axis at will, and on which are placed two enamelled plates (*k*) and (*l*), the one painted with a rectangular figure, and the other with a pattern resembling a series of steps. Both plates are illuminated by a small electric lamp placed behind them, the rectangular figure (*k*) being fixed, and the step figure (*l*) capable of being moved along the arc by means of a movable adjustment. The telescope and the arc with its enamelled plates are fixed on a firm stand, and are placed on a suitable table, at the opposite end of which the patient is seated facing the telescope, with his face in a wooden frame (*e*) and supported by a chin-rest.

The room having been darkened and the enamelled plates illuminated, the patient is directed to look directly in front whilst the

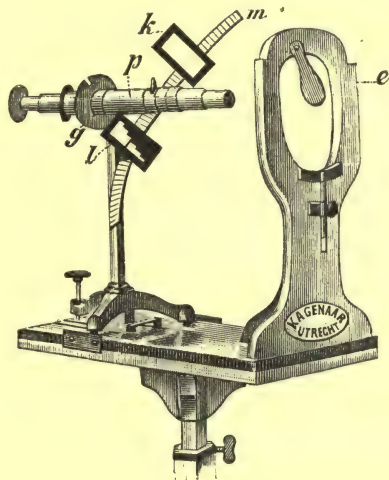


FIG. 49.—The astigmometer of Javal and Schiötz (*see* Text).

surgeon adjusts the telescope to the proper height, and focuses it until he sees through it the images of the enamelled plates clearly reflected on the cornea of the eye to be examined. Owing to the prism in the telescope the images of the plates will be doubled, and he will see four reflections (Fig. 50), two centrally placed and close to each other, and

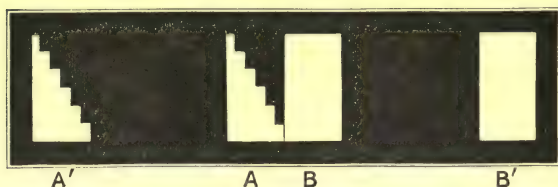


FIG. 50.—The corneal reflections with the arc of the astigmometer placed horizontally (*see Text*).

one at either periphery of the field. With the arc placed horizontally, the central figures are approximated until they exactly touch each other without overlapping, by moving the plate containing the step figure along the arc until this effect is produced. The arc is then turned from the horizontal into the vertical, and note made whether this revolution has made any difference in the relative positions of the central images. If they still touch without overlapping the refraction of the vertical is the same as that of the horizontal meridian, and there is no astigmatism; but if the images overlap or are separated from each other, then astigmatism is present.

Let us first suppose that overlapping is found. This shows that the vertical meridian forms the arc of a smaller circle than the horizontal, or in other words, that it is the meridian of higher refraction. The actual refractive difference between the meridians is estimated by the number of steps that are overlapped by the rectangular figure, each step representing one dioptré of astigmatism (*see Fig. 51*).

If, on the other hand, the figures are found to be separated, this will indicate that the vertical is the meridian of lower refraction, and it will then be necessary first to approximate the images until they touch, and then to revolve the arc back again into the horizontal position, when overlapping will be perceived, and the astigmatism is measured as just mentioned. As in a large proportion of cases it is the vertical meridian that has the higher refractive index, it is better, and usually quicker, to commence proceedings with the arc placed horizontally.

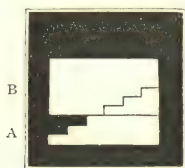


FIG. 51.—The reflections of the two central images on rotating the arc into a vertical direction; 3 dioptrés of astigmatism are present (*see Text*).

If the principal meridians are oblique the figures will not appear in the same straight line until the arc is rotated to correspond with their axes. The necessary rotation to bring the images into a straight line can be read off from a small circular scale (*g*) attached to the arc.

4. The Keratoscope—Placido's Disc.—This consists of a circular sheet of polished metal about 8 inches in diameter, fitted with a handle and painted on one side with a series of concentric black rings on a white ground. The centre of the disc is perforated with a sight-hole of con-

venient size. The patient is seated in a chair with a strong light above the head, and the room is darkened. The surgeon, seated close to the patient, but not within his near point, holds the disc before one eye so that he can see through the central aperture. The painted surface is directed towards the patient, and care must be taken not to tilt the disc forwards or backwards. The patient directs his gaze at the central sight-hole, and the surgeon immediately sees a reflection of the painted rings upon the corneal surface. If this reflection exhibits the rings as perfect circles there is no astigmatism, but if the rings are converted into ellipses the patient is astigmatic, and the long diameter of the ellipses will correspond to the meridian of lesser, and the short diameter to the meridian of greater refraction.

Placido's disc is especially useful to diagnose irregular corneal astigmatism when the ellipses are seen to be irregular, with protrusions and narrowings of their contours, and it also well exhibits the high degrees of astigmatism seen in conical cornea.

SUBJECTIVE TESTS for astigmatism:

1. Measurement by Stenopæic Slit.—It must be supposed that the patient's vision has been already tested with convex and concave spherical lenses, but without bringing the vision to normal standard. A disc perforated by a slit 2 mm. wide is placed before one eye and the other eye screened. The perforated disc is known as a stenopæic slit. This is now rotated before the patient's eye; if he is astigmatic it will be at once noticed that the vision is improved with the slit in one position, usually either vertical or horizontal. We will suppose the horizontal position of the slit to give the best vision. It will then be found that his vision is rendered worse by all other positions of the slit, and will be worst of all when the slit is placed vertically. We then proceed to find out the highest convex or lowest concave lens which gives the best vision with the slit placed first vertically and then horizontally. The difference between the two lenses thus found will be the measure of the astigmatism present. Suppose that in the case we are considering it is found that the vision with the slit horizontal is emmetropic, whilst, with the slit vertical, a concave lens of -1.5 D gives the best improvement. This shows that the horizontal corneal meridian is normal, whilst the vertical is slightly myopic; the patient will, therefore, have simple myopic astigmatism = 1.5 D in the vertical meridian. We now remove the stenopæic disc and replace it by a cylindrical concave lens of 1.5 D, and, remembering the above-mentioned property of cylindrical lenses, we place it with its axis horizontal. This will have the desired effect of correcting the myopia in the vertical corneal plane, and thus render the vision emmetropic in every direction.

2. Estimation by the Astigmatic Clock-face.—This consists of a dial fifteen inches in diameter, painted on a white ground, and marked at intervals with the hours like a clock (Fig. 52). Radii corresponding to each hour are drawn from the centre of the dial, each radius consisting of three narrow black lines equidistant from each other, and each line and space measuring 2 mm. in breadth respectively. The test depends upon the fact that if *As* is present all the radii will not be

seen with equal distinctness. The clock-face should be hung in a good light about four to six metres from the patient to be examined.

Let us suppose, as in the preceding test, a case of simple As where the vertical meridian is ametropic and the horizontal meridian is

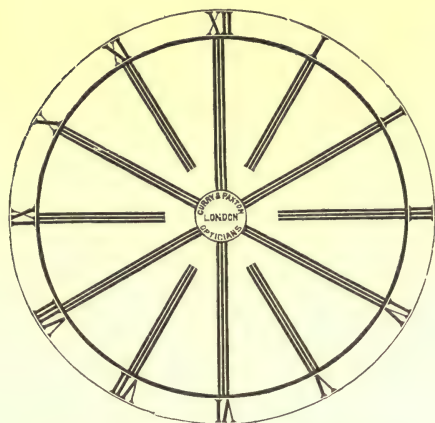


FIG. 52.—The astigmatic clock-face (see Text).

emmetropic. On looking at the clock, with the other eye screened, the patient will at once notice that only the vertical radii corresponding to the hours marked XII and VI are seen distinctly and sharply. All the other radii are more or less blurred, the horizontal ones especially so. The reason of this is that only those rays which are refracted by the horizontal emmetropic meridian of the cornea are brought to a focus on the retina. These rays are vertical in direction, and therefore cause blurring in *horizontal* lines, which appear thickened and confused.

We now endeavour to find out the highest convex or lowest concave lens which will render the horizontal lines most clear. We shall find no lens which will make these radii as clear as the vertical, but in the case under consideration — 1.5 D is the lowest lens that gives the best improvement, and will, as before explained, represent the degree of As. If we now place a concave cylinder = -1.5 D with its axis horizontal in front of the eye all the radii will stand out with equal clearness. It will be readily understood that if only the horizontal radii were seen distinctly a cylinder with its axis vertical would be required. If the astigmatism is compound it will be necessary to first ascertain the spherical lens that gives the best improvement before proceeding to examination with the clock-face.

Note.—Two points should be borne in mind when ordering cylindrical lenses.

(a) The patient should be warned that some discomfort may be experienced in becoming accustomed to their use. This discomfort varies with different temperaments, being most marked in patients of a neurotic type; and it also to a certain extent is proportionate to the strength of the cylinder ordered. It consists in a feeling of dazzling and vertigo, and often in a slight temporary hemicrania. When dealing with children it is often a wise plan to keep the eyes under atropine until the glasses have been worn for a few days.

(b) Patients who have reached middle age without having had their astigmatism corrected frequently resent cylindrical lenses in a marked degree, and often, indeed, cannot wear them. The cylindrical correction improves their vision as much as that of younger patients, but

the discomfort caused by it is so great that they prefer to sacrifice some vision and obtain comfort and what improvement they can get with a purely spherical correction.

IRREGULAR ASTIGMATISM.—In this variety of astigmatism the corneal surface has been disturbed by ulceration or has yielded in the formation of a staphyloma or a conical cornea, so that the refraction is irregular, and the resulting visual images are greatly distorted. Irregular astigmatism may also affect the crystalline lens either through changes in the structure of the lens substance, as is sometimes seen in the earliest formation of cataract, or through its displacement, as in cases of partial dislocation of the lens into the anterior chamber or vitreous. Spectacles present little chance of improvement, but low cylinders are sometimes of benefit.

ANISOMETRIA.

By this term is signified inequality of refraction in the two eyes. In small degrees it is very common to find that one eye is more faulty in its refraction than the other, either in H, M, or As. More rarely we find a difference in the *kind* of refraction instead of *degree*. Thus, one eye may be emmetropic and the other myopic; or one hypermetropic and the other myopic, and so on. When the inequality is one of *degree* only, it may generally be rectified with advantage by prescribing the suitable correction for each eye, provided that the inequality is slight or only moderate in amount, and that the patient has not grown to middle age or past without any attempt to equalise the refraction. In the former case much depends upon binocular vision; if that has been lost for long the patient will rarely tolerate any attempt to restore it by glasses; and as regards the latter case, elderly people who have never been corrected are peculiarly intolerant in this respect. When the inequality is one of *kind*, successful treatment is even more difficult, and if one eye is myopic and the other hypermetropic we frequently find that the patient uses the hypermetropic eye alone for distance and the myopic eye alone for work. It is generally best to fall in with this state of affairs if the patient has grown up, and prescribe accordingly by correcting the H for distance with a plane glass in front of the myopic eye, and, if necessary, by ordering reading glasses with the M corrected and a plane glass in front of the hypermetropic eye. In young children, however, we should always make the attempt to restore or preserve binocular vision by prescribing the correction for each eye to be worn constantly, and success will not infrequently follow. The most hopeless cases are those in which emmetropia is combined with myopia, for the patient will rapidly lose binocular vision; but even in these cases it is well, in children, to correct the myopic eye, and by stereoscopic exercises and exclusion of the emmetropic eye for some hours daily (*vide* "Strabismus") we may save the child from the deformity of a strabismus.

CHAPTER VIII.

RETINOSCOPY

AND

HINTS ON THE PRESCRIBING OF SPECTACLES.

By retinoscopy the refraction is estimated by the characters and movements of the shadow seen in the patient's eye when the retina is illuminated by the reflection of a light cast from the surface of a concave or plane mirror which is manipulated by the surgeon.

By retinoscopy we are able to detect and estimate the various errors of refraction *objectively* without reference to the patient. By it greater accuracy is obtained than by any other method, and it is consequently of especial service when the refractive error is of high degree, in astigmatism, and in estimating the refraction in young children to whom, on account of their age, a subjective test is not applicable.

The subject is not an easy one to understand, and it will be best explained by giving a short account of—

- (1) *The necessary preliminaries incidental to the test ;*
- (2) *The theory of the test ;*
- (3) *The practical application of the test.*

(1) The mirror employed may be either *concave* or *plane*. Some prefer the one, some the other, and each may be said to give equally good results. Personally, however, we much prefer and always employ the plane mirror, because, although the illumination it affords is not so bright, still the edge of the shadow, which is the important part, is better defined, and therefore easier to follow, than is the case with the concave. If a concave mirror is preferred, it is customary to employ one having a focal length of 9 inches. In either case the mirror is perforated by a central aperture, which should have a diameter of about 4 mm.

The patient's pupils must be dilated and the accommodation paralysed. By dilating the pupils a large illuminated area is obtained over which the movements of a shadow are the more easily perceived, and by paralysing the accommodation the patient is prevented from calling the ciliary muscle into play, and from stultifying the accuracy

of the test by artificially lessening the H or increasing the M that is really present.

To ensure total suspension of the accommodation, atropine is the only reliable mydriatic, and it should be instilled twice daily in a strength of gr. iv ad ʒj for a few days previous to examination. The objection to atropine is the length of time (ten to fourteen days) that must elapse after it has been given up before the patient is able to use his eyes again for ordinary near work, and this may be a matter of very serious inconvenience. Atropine, therefore, should only be employed when absolute accuracy in the test is essential, and this includes children in whom we can estimate the refraction in no other way, all cases of squint, and difficult cases of astigmatism. In other cases a mydriatic with less lasting effects than atropine should be employed, and we have an excellent substitute in homatropine. This drug dilates the pupil more quickly and as efficiently as atropine, and, although it does not paralyse the accommodation to an equal degree or with the same certainty as atropine, still, in practice it is found, in cases other than those mentioned, to sufficiently answer the purpose required in this respect; whilst it further possesses this advantage, *viz.* that its effects do not endure for more than thirty-six hours. The suspension of the accommodation is aided considerably by the examination taking place in a darkened room, and by the surgeon directing the patient to look into the distance whilst he is conducting the examination. The homatropine is best used in company with cocaine (F. 20), and one or two instillations at short intervals one hour before examination are sufficient.

The patient's pupils being thus dilated, he is seated in a chair facing the surgeon, the room is darkened, a lamp, such as is used for ophthalmoscopic purposes, is placed just above the head, and a pair of trial spectacle frames fitted on the nose. The surgeon seats himself at the distance of about 1 metre from the patient. From that position he is able to lean forward and change the lenses in the trial-frames without getting up; but he should not approach nearer than 1 metre, otherwise the rules given for the correction of the refraction will not be accurate, and he will over-correct the H and under-correct the M, as will be easily understood by referring to page 85, in the explanation of the theory of retinoscopy. It is not essential that the surgeon should wear correcting glasses if his own refraction is at fault, but it is better that he should do so if the error is of high degree, because he thereby obtains clearer impressions of the shadows seen in the observed eye.

The surgeon, supporting the mirror against the orbital arch and bridge of the nose, and employing either eye, throws a beam of light into the eye to be examined. Directing his gaze through the central aperture of the mirror, he will observe the fundus illuminated by the reflected light, and as he slightly rotates the mirror, now in a vertical and now in a horizontal direction, he will notice that, corresponding to the motion imparted to the mirror, a shadow will move across the pupil. This shadow will either move in the same direction as, or *with*, the mirror, that is, for example, to the right when the mirror is rotated to the right; or it will move in the opposite direction to, or *against*, the

mirror, viz. to the left when the mirror is turned to the right. The movement of the shadow will depend not only upon the nature of the patient's refraction, but also on the mirror employed, the direction when a plane mirror is used being exactly opposite to that seen with a concave mirror. The refraction is corrected by placing convex or concave lenses, as the case may require, before the patient's eye, the correcting one being the weakest lens that causes the shadow to be reversed, that is, to move in a direction opposite to that primarily noted.

2. To fully understand the practical details it will now be necessary to consider the *theoretical aspect* of retinoscopy, and the behaviour of the shadows both with a plane and a concave mirror.

(a) **Plane Mirror.**—The foci of plane mirrors are *upright* and *virtual*, that is, the reflected rays are not brought to any real focus, but if prolonged backwards would appear to meet at some point behind the mirror, which is known as the virtual focus of the mirror.

(L) is a lamp placed above the eye to be observed, and from it rays (A B) fall on to the mirror (M) and are thence reflected into the observed eye, where they form a small inverted image (*b a*) of (L), which will

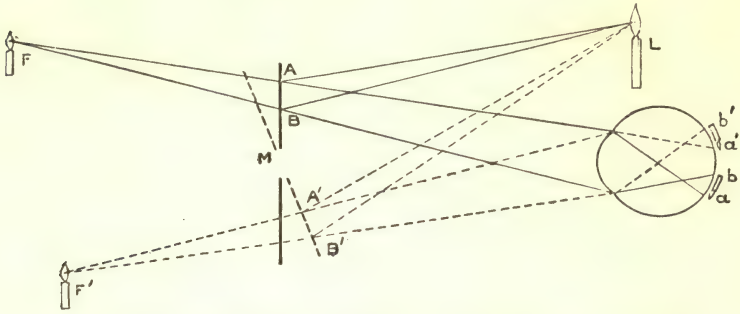


FIG. 53.—Retinoscopy with a plane mirror. (After Jackson.) (See Text.)

appear as though proceeding from (F), an upright virtual image of (L) situated behind the mirror (M). It is evident that whatever movement is imparted to the mirror (M) the displacement of the virtual image (F) will be in an opposite direction, whilst the image (*b a*) on the retina of the observed eye being inverted as regards (F), will always move in an opposite direction to (F), that is, in the same direction as (M). Thus, if (M) be rotated upwards rays (A' B') will be reflected on to the retina at (*b' a'*), which is at a higher spot than (*b a*), and will appear as though proceeding from (F'), which is now displaced to a lower level than (F). Thus, with the plane mirror the movements of the mirror and the image always correspond, or as it is generally expressed, the image moves "with" the mirror.

(b) **Concave Mirror.**—The condition is exactly the reverse. The foci of concave mirrors are *real* and *inverted*. Thus, if rays (A B) proceeding from the lamp (L) impinge on the mirror (M) they will be brought to a focus at (F), where a small inverted image will be formed,

and then passing into the observed eye will form on the retina an *upright* image (ab) of the lamp (L). Now it is evident that in whatever direction (M) is rotated (F) will be shifted in a corresponding direction, whereas (ab), being inverted as regards (F), will move in an opposite direction to (F) and (M). Thus, if (M) be rotated upwards the rays ($A'B'$) will be focussed at (F'), and (ab) will be lowered to ($a'b'$). Thus with the concave mirror the movements of the reflected image are always in an opposite direction to, or "against," those imparted to the mirror.

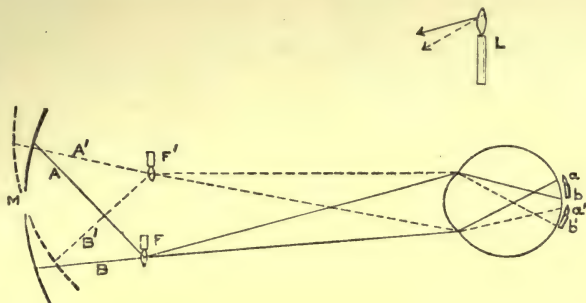


FIG. 54.—Retinoscopy with a concave mirror (*see* Text).

In retinoscopy the image on the retina of the observed eye is seen as an illuminated area surrounded by a shadow, which is caused by the presence of diffusion circles. The greater the ametropia or abnormality of refraction in the observed eye the denser and more numerous will be these diffusion circles, and consequently the feebler will be the illumination obtained. The movements of the illuminated area are gauged by the corresponding movement of the shadow, which with its defined edge are more easy to follow than those of the area itself, and it will be found that the rate of movement of the shadow will vary inversely with the degree of ametropia present. Thus a bright illumination and rapidly moving shadow indicate a slight degree of ametropia, and conversely.

Now the *apparent* movement of the shadow, as the observer sees it, and its *real* movement are not always one and the same thing, but depend upon the refraction of the observed eye. We have already seen that with the plane mirror the real movement of the shadow is always in the same direction as the rotation of the mirror, and that with the concave mirror the shadow always moves in a direction reverse to that taken by the mirror. If the observed eye is *emmetropic* or *hypermetropic*, the rays of light emerging from it are either parallel or divergent respectively (Figs. 55, 56), and cannot therefore be brought to any focus until reaching the observer's eye placed behind the sight-hole of the mirror. The observer in these cases therefore sees the movements of the shadow exactly as they really occur, and consequently we say that in emmetropia and hypermetropia the shadow always moves *with* the plane mirror, and *against* the concave mirror.

In *myopia* the case is somewhat different. The rays that emerge from a myopic eye are always convergent, and are brought to a focus at its punctum remotum (*see* "Myopia"). If the myopia is of so small a degree (less than 1 D) that the punctum remotum is situated behind the observer's eye, placed at 1 metre from the patient (*see* R, Fig. 57), the rays, although convergent, will not be brought to a focus before

reaching the observing eye, and in this case, as in emmetropia and hypermetropia, the real movement of the shadow will be perceived. But if (see Fig. 58) the punctum remotum is situated between the

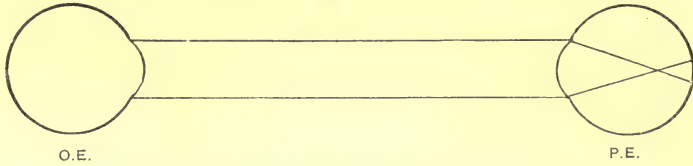


FIG. 55.—Course of emergent rays in emmetropia.

observed and observer's eye (myopia of 1 D or more), then the converging rays will form at this spot (R) a small inverted aerial image,



FIG. 56.—Course of emergent rays in hypermetropia.

which the observer will see instead of the image on the retina of the observed eye. The *apparent* movement of this image, being inverted,

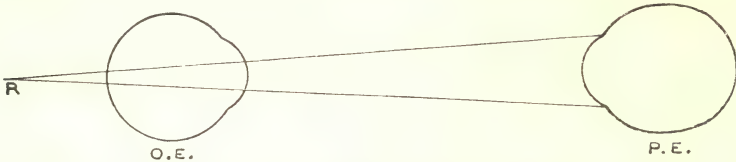


FIG. 57.—Course of emergent rays in myopia of less than 1 D. For the sake of clearness the refraction of (O.E.), the observing eye, is not taken into account. (R) Punctum remotum. (P.E.) Observed eye.

will be always in the opposite direction to the *real* movement taking place on the retina of the observed eye, and therefore, in cases where the observed eye is myopic to the extent of 1 D or more, the shadow

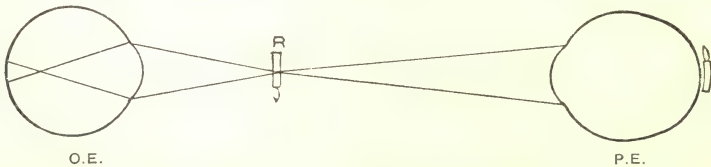


FIG. 58.—Course of emergent rays in myopia of more than 1 D. (R) Punctum remotum of (P.E.), the observed eye.

will always appear to move *against* the plane mirror and *with* the concave mirror.

To sum up :—If a plane mirror is used the shadow moves *with* the

mirror in E, H, and M of less than 1 D, and *against* the mirror in M of 1 D and more.

If a concave mirror be employed, the shadow moves *against* the mirror in E, H, and M of less than 1 D and *with* the mirror in M of 1 D or more.

From what has been said it will be understood that the reversal of the shadow indicates that a hypermetropic refraction has been over-corrected to the extent of about + 1 D, and that a myopic refraction has been under-corrected to the same extent. It follows that if the refraction be emmetropic the shadow will be well reversed when + 1 D is placed before the observed eye.

3. Practical Application.—The patient should be made to look into the distance, a little to one side or the other, and never *at* the surgeon. In this way the direct illumination of the macula, which is apt to induce accommodative efforts, is avoided.

The refraction of the two principal meridians should be tested separately, so that small degrees of astigmatism shall not escape notice. In all cases of spherical error, and in many cases of astigmatism, the planes of these meridians are vertical and horizontal, but in some cases of astigmatism they are placed obliquely, and when this is so, the mirror whilst correcting must be rotated along a corresponding oblique plane, otherwise the shadows will become confused and an accurate estimation impossible.

It is a good plan to notify results by drawing two cross-lines indicative of the two principal meridians and the direction of their planes, and marking against each the nature and degree of the refractive error.

Thus—



After the estimation has been completed the result should, except in the case of young children, be checked by examination with the test-types; remembering to subtract 1 D if the error is +, and to add 1 D if the error is -.

In hypermetropes, after paralysis with atropine, it is often necessary to deduct a further amount varying from + 0.5 D to + 1 D to allow for the normal *tone* of the ciliary muscle, which frequently in them is somewhat hypertrophied. No allowance of this sort need be made for myopes, as they employ their accommodation less than emmetropes, and their ciliary muscles consequently tend to be abnormally small.

In young children with oblique astigmatism the direction of the corneal axes may be gauged with very fair accuracy, by placing the correcting cylinder and a sphere of 1 D less than the correction in the trial-frame, and rotating the cylinder until the shadows move vertically and horizontally. The axis in which the cylinder must be placed in

the spectacles to be prescribed is then read off from the tangent scale on the trial-frame.

The Practical Correction of the Shadows with the Plane Mirror.

—It is presupposed that the accommodation is completely relaxed.

a. The shadow moves with the mirror. The patient is therefore hypermetropic, emmetropic, or slightly myopic.

i. Place + 1 D in the trial-frame. If the shadow still moves *with* the mirror, H is present. Continue placing + lenses before the eye; the lowest that causes the shadow to move *against* the mirror corrects.

If the shadow moves *against* the mirror with + 1 D the patient is emmetropic or slightly myopic. In this case:

2. Place + 0.75 D in the trial-frame. If no definite shadow is obtainable, or it is still faintly moving with the mirror, the patient is emmetropic. If the shadow is decidedly reversed the patient is slightly myopic (– 0.25 D).

b. The shadow moves against the mirror. This always indicates *myopia*. Place successive – lenses before the eye until the lowest lens that causes the reversal of the shadow is found.

The Correction of the Shadows with the Concave Mirror.—As has been explained, the shadows are the exact reverse of those obtained with the plane mirror. Their correction is made in a precisely similar way, and need not, therefore, be further detailed.

HINTS ON THE PRESCRIBING OF SPECTACLES.

The prescribing of suitable spectacles is second only in importance to the proper correction of refractive errors. The following are the chief points.

Size and Shape of Lenses.—The lenses should always be of good size. It is a mistake to think that small glasses attract less observation or are more becoming in appearance than those of proper proportions. Large *circular* lenses (A) (Fig. 59) are the best for hunting, shooting,

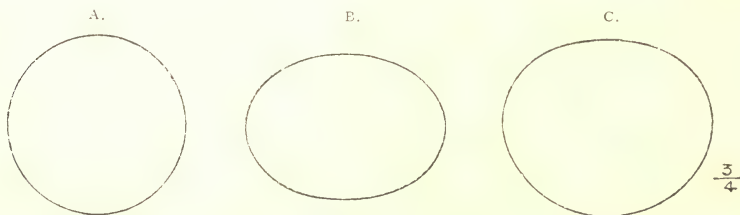


FIG. 59.—Various shapes of lenses. A. Circular. B. Large oval. C. Round oval.

etc., where it is important for the patient to have a wide range of vision through his glasses without being worried by the sight of the spectacle rims. They are also very suitable in “strabismus concomitans,” because they prevent the patient seeing over or round the glasses, which young children will often endeavour to do.

For ordinary distant wear, the "large oval" shape (Fig. 59, B) is the best.

For reading, the "round oval" or *pantoscopic* shape (Fig. 59, C) are to be preferred. Half-lenses (Fig. 60, A) are very useful for near work when the patient has constantly to be looking up from work to view more distant objects. Care should be taken that the upper rim lies below the pupil when the patient looks straight forwards, otherwise the rim will interfere with his distant vision.

When glasses are required for both distant and near wear, spectacles

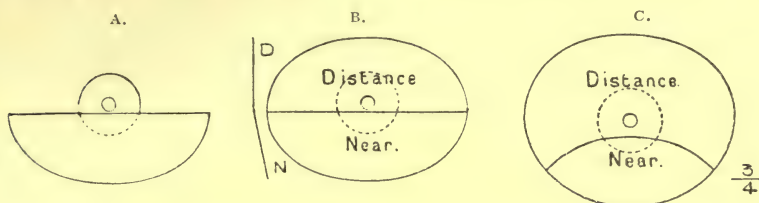


FIG. 60.—Lenses for combining distant and near vision. A. Half-lens. B. Angled lenses. C. Bifocal lenses.

combining lenses for both objects may be often prescribed. Either *bifocal lenses* (Fig. 60, C) or Franklin's *angled lenses* (Fig. 60, B) may be ordered. In both the lower half contains the reading glass and the large upper portion the distance lens. The bifocal are the preferable, as there is less chance of the patient being annoyed by the sight of the line of junction of the two lenses. They are best reserved for cases that only require spherical lenses. They often cause some discomfort when first used. They should not be ordered in old people with a *high* degree of H, because whenever such patients look down they look through their reading glasses, which confuse their sight and may lead to a serious fall when going downstairs, etc. In high myopia, on the contrary, both the bifocal and Franklin's pattern answer admirably.

Shape of Frames.—Spectacles, never pince-nez or folders, should be prescribed for children. If spectacles are to be worn constantly, twisted wire arms are comfortable, light, and help to hold the spectacles

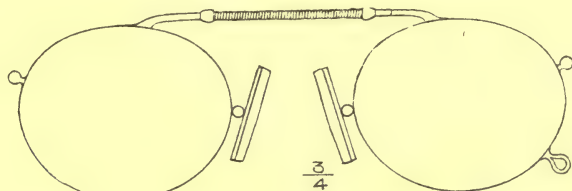


FIG. 61.—Pince-nez with horizontal spring adjustment.

well in position. If astigmatic glasses are prescribed spectacles are to be preferred. The best alternative form is pince-nez with a horizontal spring (Fig. 61): folders must *never* be ordered with cylinders. Spectacles should be insisted upon in treating squint.

Tinted Glasses.—Glasses shaded with a light neutral tint are very useful in myopia because of the unpleasant dazzling that concave lenses not infrequently produce. Strong lenses, both convex and concave, should always be thus tinted for outdoor use in hot or glaring climates. Reading glasses, as a rule, are better not tinted. Neutral tint is preferable to the old-fashioned cobalt blue because it does not interfere with colour-vision and also affords greater shade.

Protectors.—The best to employ are coquilles or curved glasses. They must be ordered of large size, so as to give sufficient side protection. In tropical climates and in snow these glasses tinted with peacock or spectrum blue are of the greatest service.

Varieties of Lenses.—Many surgeons restrict themselves to the employment of biconvex and biconcave lenses, but other forms have on occasions certain advantages.

Plano-convex and *plano-concave* lenses give a rather larger field than biconvex and biconcave lenses, and are to be preferred for distance in the higher degrees of H and M—from about 8 D upwards. They are not, however, suitable for reading glasses.

Concavo-convex lenses or meniscoids form good reading glasses for low powers, up to + 4 D, and are often preferred to biconvex lenses. The best curve is one in which the concavity is in proportion to the convexity as 1 is to 6. They are not, however, suitable for hospital patients as their cost is considerably more than that of biconvex lenses.

Adjustment of Spectacles.—When spectacles fit properly they should lie as close to the eyes as possible without touching the lashes. The importance of this lies in the fact that the value of a convex lens becomes increased, and that of a concave lens decreased, as the spectacles slip down over the nose (see H, page 52, and M, page 61). The bridge should support the lenses close to the eyes without hurting the skin, and it is well to see that the lower edge of the bridge is rounded off so that it cannot scrape the nose. It may be lined with tortoiseshell if the skin is very tender. Each pupil should look through the centre of the lens. This, the correct “**centreing**” of the glasses, is the most important point of all, unless a prismatic effect is wanted, in which case the glasses are ordered to be “**decentred**” outwards or inwards; that is, the lenses are so adjusted that their optical centres lie outside or inside the pupillary centres according to the prismatic effect desired (see also “Decentration of Lenses”).

To Measure for Glasses.—The patient should always be properly measured and fitted by an experienced person, but a ready method of measuring for spectacles will sometimes be of great service to the surgeon. A set of different-sized spectacle frames should first be obtained, comprising all the needful variations in size, shape, and character of bridge, etc. The surgeon tries on different frames, firstly to find a pair of suitable size and width, and secondly to discover the type of bridge necessary, with its height and position. Each pair of frames should be marked with its various measurements in inches. All that is left is to find the *exact* distance between the pupils, or the correct “centres” as it is technically called. The patient looks directly in front

whilst the surgeon places a piece of white card across the nose under the eyes, and marks off with a pen or pencil the position of each pupillary centre. The space between the marks on the card can then be measured by an inch-rule. If the patient has a concomitant squint a mark must be made on the centre of the nose in a line with the pupils, and the distance of each pupillary centre from the mark taken separately whilst the other eye is screened. The frames that have been selected, and the distance between the pupils can then be forwarded to the optician, who will make the spectacles accordingly.

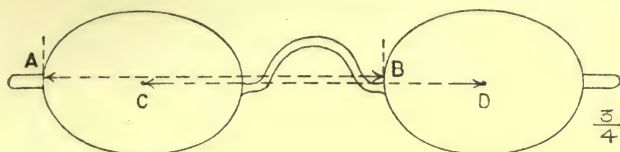


FIG. 62.—Shows how the centres of spectacles are measured and proved correct. The line (A B) is exactly equal to the line (C D) connecting the optical centres of the lenses. It is much easier to measure (A B) than (C D), and if (A B) corresponds to the distance between the pupillary centres, the latter, when the spectacles are adjusted, must be opposite (C) and (D) respectively, and the glasses are then said to be correctly "centred." (See also Text.)

To make certain that a pair of spectacles is correctly centred, measure the distance between the outer rim on one side where it meets the knuckle or joint and a corresponding point on the *inner* rim of the other side (see Fig. 62). This measurement should exactly correspond to the distance between the pupils. This distance varies on an average between two inches in children to two and a half inches in adults, though in exceptional cases it may be very slightly more or less.

CHAPTER IX.

SOME POINTS IN THE DEVELOPMENT OF THE EYE.

An acquaintance with the development of the eye forms an useful prelude to a study of its diseases, and a brief outline of the main facts is therefore inserted at this point.

Primary Optic Vesicle.—The embryonic eye in its initial stage consists of a hollow outgrowth from the primitive forebrain known as the primary optic vesicle, which is completely surrounded by mesoblast and epiblast (Fig. 63).

Secondary Optic Vesicle.—The epiblast, where it lies adjacent to

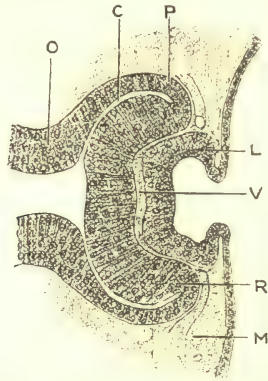


FIG. 63.—Horizontal section through the eye of an embryo rabbit (Kölliker).

(o) Optic stalk. (c) Cavity of the primary optic vesicle. (p) Cells forming the pigment layer of the retina. (r) The inner wall of the primary vesicle, ultimately forming the retina proper, which is invaginated by (l) the ingrowth of the primitive lens. (m) The mesoblast, which at (v) is growing in to form the vitreous.

the anterior face of the primary vesicle, becomes thickened and invaginated so as to form a distinct island of cells, *the rudimentary Lens*, which presses upon the primary vesicle and causes an invagination of its walls. In this way the hollow tube becomes converted into a cup-

shaped cavity, which is known as the secondary optic vesicle, into which the primitive lens is received (Fig. 63).

Retina and Optic Nerve.—The posterior portion of the primary vesicle does not share in the invagination, but remains as a hollow tube, the *optic stalk*, which becomes developed into the *optic nerve* (Fig. 63). From the walls of the secondary vesicle, which of course consist of two layers, is formed the *Retina*. From the inner wall, which is the thicker, all the fibrous and nervous portions of the retina are developed, whilst the outer wall is finally represented by the layer of hexagonal pigment-cells (Figs. 63 and 64). The mouth of the secondary cup is at first wide and shallow, and filled by the rudimentary lens, and the retinal elements are then only formed as far as what is ultimately known as the *Ora Serrata*; but as growth proceeds a thin stratum of the anterior wall of the cup grows down over the lens so as to enclose it, and this layer becomes the *Pars Ciliaris Retinæ*.

The Choroidal Fissure and Vitreous.—Whilst the above phenomena

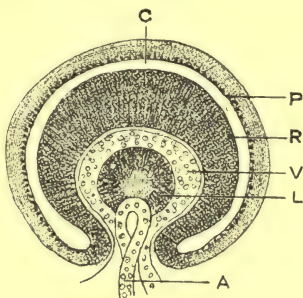


FIG. 64.—Vertical section through the eye of a human embryo of four weeks, showing the anterior half viewed from behind (Kolliker).

(c) Cavity of the primary optic vesicle. (P) Outer wall of the primary vesicle, forming the pigment-cells of the retina. (R) The invaginated inner wall of the primary vesicle forming the retina proper. (v) Embryonic vitreous entering at (A) the foetal cleft, which also marks the entrance of an embryonic blood-vessel. (L) The rudimentary lens.

are proceeding another invagination has taken place below, in which the whole of the primary outgrowth participates. A process of mesoblast is thrust upwards, invaginating the ventral walls of the optic stalk and secondary vesicle, and causing a cleft to appear, which is known as the *Choroidal Fissure* or *Fœtal Cleft*. Into this cleft the mesoblast grows, permeating the cavity of the secondary vesicle to form the *Vitreous*, whilst that received into the cupped optic stalk becomes the *central vessels of the retina*. In a short time a downgrowth of the walls encloses these processes, and the foetal cleft then becomes obliterated.

The Choroid and Iris.—The uveal tract is developed from the mesoblast immediately surrounding the secondary optic vesicle. Its growth and development follow closely upon those of the walls of the vesicle from which, as already mentioned, the retina is formed, and in the early stages that part only of the uveal tract which becomes the

Choroid is apparent; but as the walls of the secondary vesicle grow over the lens the adjacent mesoblast becomes developed into the *Ciliary Processes* and *Iris*. Thus it happens that if any portion of the choroidal fissure remains unclosed, as sometimes occurs, there will be at this spot a defect in the development of the uveal tract, or *coloboma*, which frequently involves the adjacent walls of the secondary optic vesicle. Thus in a *coloboma* of the choroid the retina is frequently absent as well as the choroid.

Sclerotic, Cornea, Conjunctiva, Eyelids, and Anterior Chamber.—Another layer of mesoblast, external to that forming the choroid and iris, is developed into the *Sclerotic* and *Substantia Propria of the Cornea*. Anteriorly, a process of the cuticular epiblast forms the *Ocular Conjunctiva*, and this, as it passes over the cornea, becomes reduced to a

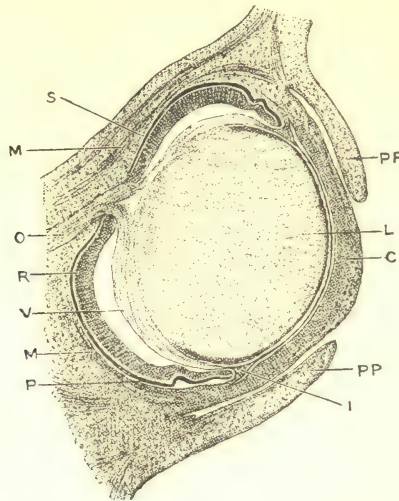


FIG. 65.—Horizontal section through the eye of an embryo rabbit (Kölliker).

(o) Optic nerve. (r) Retina. (v) Shrunk vitreous. (p) Pigment layer of the retina. (i) Rudimentary iris. (pp) Integumental folds forming the eyelids. (c) The cornea. (l) The lens covered anteriorly by the membrana pupillaris. (s) Sclerotic. (m) Ocular muscles.

stratum of cells which forms the *Corneal Epithelium*. The *Palpebral Conjunctiva* is formed by a reduplication of this process over the inner surface of the two integumental folds which, at a comparatively late period of foetal life, grow towards each other to form the *Eyelids*. Upon the approximation of the latter, their adjacent *epithelial* surfaces become united until a short time before birth, when they are finally separated; so that in this way the differentiation between the free edge of the lids and the margin of the conjunctival lining is completed. The *Anterior Chamber* is not formed until a late period of foetal life, so that the cornea lies for a considerable time in apposition with the iris and anterior pole of the lens, which may account for some cases of congenital glaucoma and anterior polar cataract.

The Lens, Hyaloid Artery, Fibro-vascular Sheath, and Capsulo-pupillary Membrane.—The method by which the rudimentary lens is developed has already been mentioned. It at first lies in contact with the walls of the secondary vesicle, but with the ingrowth of the meso-blast to form the vitreous its posterior surface becomes widely separated from the retina. At the same time the general growth of the globe proceeds at a more rapid rate than that of the lens, so that the equator gradually becomes separated from the ciliary processes, and the lens is left suspended in the cavity of the globe by the *Zonular Ligament*, which is probably therefore, as suggested by Collins,* of the nature of a long drawn-out adhesion. Nothing definite is at present known as to the exact origin of the *Lens Capsule*, it being regarded by some as mesoblastic, and by others as derived from the epiblast, as is the lens itself.

During a considerable portion of foetal life the lens is surrounded by a *fibro-vascular network* or *sheath*. Posteriorly, this is maintained by the *Hyaloid Artery*, which during foetal life is the main continuation of the central artery of the retina, and runs forwards through a central canal in the vitreous (*the canal of Stilling*) to the posterior aspect of the lens, where it spreads out into a network of arterioles which cover this face of the lens. These, creeping round its equator, are reinforced by a fresh series of vessels derived from the vessels of the iris, and together form a similar vascular network over the front of the lens, this anterior portion of the enclosing network being known as the *Capsulo-pupillary Membrane*. About the seventh month the central hyaloid artery and its branches shrink and disappear, though occasionally remnants persist after birth. With it the capsulo-pupillary membrane also becomes lost, fragments being not infrequently left as greyish tags springing from the surface of the iris and attached at their other end to the anterior lens capsule.

* 'Anatomy and Pathology of the Eye,' p. 1 *et seq.*

CHAPTER X.

DISEASES OF THE CONJUNCTIVA.

ANATOMY.—The conjunctiva is a delicate membrane lining the internal surface of the lids (*palpebral conjunctiva*) and the anterior surface of the eyeball (*ocular or bulbar conjunctiva*).

The *palpebral* conjunctiva is closely adherent to the tarsus. At the anterior free margins of the lids it becomes continuous with the skin, whilst posteriorly it is reflected on to the eyeball, the line of reflexion being known as the fornix, and the space thus contained between the lid and the globe as the retro-tarsal fold. At the puncta lacrymalia the epithelium is continuous with the lining membrane of the canaliculi and lacrymal sac.

The *ocular* conjunctiva is much paler in colour, and is loosely connected to the sclerotic by a layer of areolar tissue—the subconjunctival or episcleral tissue—which, in the retrotarsal folds, is largely of an adenoid character. Around the corneal margin the conjunctiva is closely adherent to the sclerotic, but is represented over the cornea by several layers of epithelial cells. At the inner canthus the reflexion of the conjunctiva from the globe on to the upper and lower lids forms a vertical fold known as the *plica semilunaris*, which is a vestigial remnant of the third eyelids seen in birds. This fold is situated just to the outer side of a small space called the *lacus lacrymalis*, occupied by a red fleshy elevation known as the *lacrymal caruncle*, upon the surface of which are commonly found a few downy hairs.

The conjunctiva, which is not a very vascular membrane, is supplied by twigs from the terminal branches of the ophthalmic artery. On the globe these vessels form a fine network radiating from the periphery towards the cornea. This is an important point in the diagnosis of conjunctival inflammation, the congestion being always most marked towards the periphery, where the vessels are largest.

The nerve-supply is from filaments of the ophthalmic division of the fifth nerve.

CATARRHAL CONJUNCTIVITIS—CATARRHAL OPHTHALMIA.

ACUTE CATARRHAL CONJUNCTIVITIS is an inflammation of the conjunctiva covering the eye and lining the lids. It may come on without

any apparent cause, or it may be produced by rapid alternations of temperature, or by exposure of the eye to cold. It also frequently follows the acute exanthemata, especially measles.

It may follow the inoculation of some poisonous material in the shape of dust, etc., and we have seen many cases in London where it has resulted from the filthy dust blown off the wood pavements. Infection through fingers from impetiginous sores is frequent in children, and extension from a lacrymal abscess is also a not uncommon cause.

Catarrhal ophthalmia will sometimes assume an epidemic character, and large numbers in the same locality will suffer from it; or it will attack every member of a family in succession, notwithstanding that due precautions have been taken to prevent it spreading by direct communication.

In a large proportion of cases, and without doubt in all epidemics, the inflammation is the result of a specific germ. It is possible, and indeed probable, that many varieties of micro-organisms may, under favouring conditions, set up an acute catarrhal inflammation; but two varieties may specially be mentioned as having been experimentally proved to be the exciting cause in many cases. The one is the *Koch-Week's bacillus*, a very delicate rod resembling that of mouse septicæmia, and the other the *Pneumococcus of Fraenkel* (Morax and others). Attempts have been made to classify pneumococcic conjunctivitis as a distinct variety of catarrhal inflammation, but clinically such a differentiation is unimportant. It is to be remembered that the latter bacillus is an occasional inhabitant of the healthy conjunctiva, and the mere discovery of its presence is not, therefore, a sufficient proof of its specific action.

Symptoms.—A feeling of grittiness, as if dust or fine sand were in the eye, with some stiffness of the lids. The conjunctiva becomes red, and this increase of vascularity generally commences from the circumference of the globe, and fades as it approaches the cornea (*see also* "Anatomy" page 96). In the advanced stage of this affection the white of the eye becomes of one uniform red colour. The redness is superficial, and of a brighter and darker shade than that caused by inflammation of the deeper structures of the eye, for which it can hardly be mistaken. Further, if pressure in an upward or downward direction be gently made with the finger through the lower lid, the congested tissue will be correspondingly elevated and depressed on account of the loose attachment of the subconjunctival tissue. This movement cannot, of course, be obtained in deep congestion of the eyeball itself.

There is an increased secretion from the surfaces of the eye and lids; at first only of mucus, but afterwards of muco-pus, small quantities of which will collect in little beads over the caruncle at the inner angle of the eye, or form little scabs on the edges of the lids by caking on the eyelashes. If the lower lid be drawn down by the finger, one or two streaks of pus or lymph will be often seen in the oculo-palpebral fold. The patient complains that the lids are sticky, and that in the morning they are gummed together by dried secretion. On looking at the eyes, there is a peculiar sticky and gummy appearance, which is quite characteristic of the disease. There is often

associated with these symptoms chemosis of the conjunctiva and swelling of the lids. The conjunctiva looks blown up from the serous effusion into the subjacent cellular tissue, sometimes to an extent sufficient to make the cornea appear sunken below it. The cornea is clear, and the pupil is active. The rapid action of the pupil will at once decide that the inflammation is superficial and that the iris is not affected by it.

Catarrhal ophthalmia usually commences in both eyes simultaneously, or one eye may be attacked a little in advance of the other, but it is seldom that this disease is limited to only the one eye. In this respect catarrhal ophthalmia offers a marked difference from gonorrhœal ophthalmia, which is generally, in the first instance, strictly confined to the one eye (*see "Gonorrhœal Ophthalmia"*).

Prognosis.—This affection is usually very amenable to proper treatment, and the eyes will recover without a trace of the disease remaining. But if no treatment be adopted, or unsuitable remedies be used, the conjunctival inflammation may extend to the cornea, and keratitis with superficial or deep ulcerations may follow.

Treatment.—The disease requires energetic treatment from the first, and nothing is better than to start by painting the conjunctival surfaces of the lids with some strong stimulant. Generally speaking, a solution of the nitrate of silver (grs. x ad ʒj) is the best drug for the purpose, but in mild cases protargol also answers very well. The latter, to be efficient, must be used in strong solutions, and we usually employ one of 30 per cent. The great advantages of protargol are that, unlike the nitrate of silver, it causes very little pain, and can be used daily, which is rarely advisable with the silver solution; but, on the other hand, its action is not so speedy nor so energetic. In either case the lids are everted, and having been dried with a dossil of wool, are brushed gently over with a camel's-hair pencil dipped in the solution. Only enough fluid should be in the brush to make the necessary application; if the solution is in excess it is very apt to trickle over the cornea, and if the nitrate of silver is being employed this causes much unnecessary pain, besides disturbing the corneal epithelium. The solution is especially apt to get on the cornea when painting the upper lid, and in order to protect the former it is a good plan to slip a thin strip of damp, absorbent wool under the everted tarsus during the application.

After the painting with silver solution the eye should be gently washed over with a stream of water or boracic lotion. It has been very generally recommended to use a weak solution of common salt, which precipitates the silver, but, as a matter of fact, the silver, if not used in excess, becomes almost immediately precipitated by means of the tears before any salt solution can be applied, and the latter is therefore unnecessary when proper care is taken, and it has the disadvantage of increasing the smarting and pain.

The immediate result of the application is a temporary increase in the subjective symptoms and in the quantity of discharge. This lasts for an hour or two, and is followed by marked improvement of the general condition. The improvement, however, is not always per-

manent, and it is generally necessary to repeat the application according to the progress made. As a rule it is not advisable in catarrhal conjunctivitis to paint the lids with silver solution more often than every other day, and as the intensity of the congestion subsides so the applications should be gradually discontinued.

In addition to these measures, the eye should be washed out four or five times daily with some astringent lotion, of which the zinc chloride (F. 54), or zinc sulphate (F. 55), or the Hydrarg. Perchlor. (F. 46) are the most useful; or instead, the lotion may be employed as drops, to be instilled after previously washing out the sac with a solution of boric acid.

The most convenient method of cleansing the conjunctival sac is the glass eye-bath (Fig. 66), which is filled with the solution and then applied to the eye. Its curved rim is shaped to fit the orbital margin against which it is pressed, whilst the patient immerses the eye in the lotion and moves it from side to side so as to wash the discharge out of the sac.

With young children the irrigation must be carried out by the nurse in the manner described on page 103 in dealing with ophthalmia neonatorum.

To prevent the gumming together of the eyelids during sleep, a little Unguent. Cetacei or vaseline should be smeared along their tarsal borders every night. At the commencement of the attack the bowels should be acted on by some purgative, and if the patient is hot and thirsty an alkaline or effervescent draught may be prescribed, but as a rule tonics, such as bark, quinine, or iron, will be required; and these are given with most benefit after the first febrile symptoms, which often usher in an attack of catarrhal conjunctivitis, have passed away.

The contagiousness of the disease must always be borne in mind, and strict cleanliness observed. The hands of the nurse should be washed after each application to the eye; the patient's towels should be kept apart, and absorbent wool or linen rags, which should be subsequently burnt, used for wiping the eye. The disease will rapidly spread through a crowded community, such as a workhouse or school, by inattention to these points, and it is therefore the best and safest plan to insist upon the isolation of any case that breaks out in such institutions.

CHRONIC CATARRHAL CONJUNCTIVITIS may be consequent on acute catarrhal ophthalmia, the acute disease subsiding into a chronic form, but this is quite exceptional. Chronic conjunctivitis generally occurs in patients who are below the standard of health, and in those who earn their living by the long-continued use of their eyes for fine work.

Thus it is a frequent complaint amongst both young and old patients who suffer from some severe uncorrected error of refraction, more particularly hypermetropia and astigmatism. It is predisposed to by certain surroundings, such as constant exposure to cutting winds, or to air vitiated by pungent fumes as in many factories or in



FIG. 66.—Glass eye-bath.

rooms charged with tobacco smoke. It may also arise secondarily to inflammation of the tarsal borders of the lid or chronic disease of the lacrymal apparatus or nose. A large number of cases, however, occur in old subjects in whom it is impossible to trace an exciting cause.

Symptoms.—The eye has a reddish and irritable appearance; it will not face the light without a sense of discomfort and watering. The caruncle and edges of the lids often look red and prominent, and the secretion from the mucous surfaces of the lids and globe is slightly increased. Reading or fine work soon tires the eye, and causes it to flush up. The patient is generally more or less out of health, oftentimes used up from want of rest.

In old people the frequent dragging upon the lower lid in the act of wiping the eye is, on account of the slackness of the tissues in old age, followed in course of time by some permanent eversion or ectropion of the lid, by which the punctum lacrymale is drawn away from the globe and rendered useless in the removal of the tears. The latter then run over the cheeks, excoriate the borders of the lids, and aggravate all the symptoms, thus forming a vicious circle, with ever increasing distress to the patient.

Treatment.—When there is reason to believe that over use of the eyes has been the predisposing cause of the disease, rest must be strictly enjoined for a time and search made for errors of refraction, which should be corrected by suitable glasses. The state of the patient's health is of much importance, and any irregularity in the discharge of the functions of the various organs should be corrected.

Attention should be paid to the avoidance of any direct irritation, and the patient therefore enjoined to keep away from vitiated atmospheres, whilst protection from the effects of glare, dust, and keen winds is effected by ordering curved protectors of a fairly dark neutral tint.



FIG. 67.—Drop bottle.

Locally, when there is much secretion, stimulating drops or lotions are very useful, especially those containing salts of zinc (F.F. 25, 54). A weak solution of the acetate of lead (F. 49), provided there is no abrasion of the cornea, is also an excellent lotion. If the case is severe an occasional painting with nitrate of silver or protargol hastens the cure, but it is rarely necessary to do more than paint the *lower* lids, where the disease is always most marked. The tarsal edges of the lids should be anointed at night with a little Ung. Boracic to prevent gumming and to heal any excoriations; or if there is much secretion from the Meibomian follicles the Ung. Hyd. Nit. Dil. (F. 65) may be used advantageously.

Ectropion and eversion of the punctum lacrymale will require special treatment, which will be found described under "Diseases of the Lids."

Mention must also be made of a mild form of catarrhal inflammation known as **Diplo-bacillary Conjunctivitis**. Our knowledge of the

affection is chiefly due to two papers, one by Morax,* who was the first to give a succinct account of the affection, and the other, published at the same time, by Axenfeld,† describing the morphological and biological properties of the specific diplo-bacillus from which the inflammation takes its name.

In its clinical aspects the disease closely resembles an ordinary mild attack of catarrhal inflammation, but it appears to be limited to adults, and is always bilateral. It comes on suddenly without apparent cause, reaches its height in two or three days, and, if not treated, may linger on for weeks without showing any disposition to subside. The subjective symptoms are slight, and objectively the eyes are seen to be somewhat flushed; there is a slight muco-purulent discharge with morning gumming of the lids; and generally some reddening and irritation about the ciliary borders, especially marked at the canthi.

The specific germ is a short, very thick diplo-bacillus, which is easily found, and is in abundance in the muco-purulent secretion. It is non-pathogenic for animals, but reproduces the disease when a pure culture is inoculated into the human conjunctival sac.

Treatment.—The inflammation readily yields to the use of astringent lotions, such as the salts of zinc. Strict cleanliness and the keeping apart of the patients' towels, handkerchiefs, etc., by which the virus may be carried to others, should be enjoined.

PURULENT CONJUNCTIVITIS.

A. PURULENT CONJUNCTIVITIS OF NEWLY-BORN INFANTS—*Ophthalmia neonatorum*—is one of the most important diseases of the eye which the surgeon can have under his care. When rightly treated it is one of the most remediable, but when neglected, or, what is often worse, when unsuitable and improper remedies are used, it is one of the most disastrous of all the inflammatory affections of the eye. The responsibility of any one undertaking a case of purulent ophthalmia who is not thoroughly acquainted with its nature and treatment is very great. Many a useful life has been blighted in the first month of its existence by irreparable blindness, which might have been prevented if the simple means which seldom fail to arrest this formidable disease had been rightly applied.

Purulent ophthalmia usually commences on the second or third day after birth; but the onset is occasionally delayed until the sixth or seventh day, in which case the inoculation has probably occurred since birth, through the unclean hands of the nurse, or possibly of the mother herself. In all other cases the disease results as a direct inoculation from the vaginal discharge of the mother at the time of birth, and depends in its severity upon the intensity of the inoculating virus. Thus the worst cases are those in which the mother is suffering from a gonorrhœal vaginitis, and in these the course of the disease is identical with that run by gonorrhœal ophthalmia in adult life.

Both eyes are commonly affected simultaneously, but to this there

* 'Ann. d'Oculistique,' vol. cxvii, 1897, p. 1.

† 'Central. f. Bakt. Parasit., etc.,' Band xxi, January 1897, p. 1.

are a few exceptions; thus, one eye only may be involved, or the first eye may suffer twelve or twenty-four hours in advance of the second.

Symptoms.—The first indication of the disease is usually detected by the nurse, who notices that there is a slight discharge from the eyes, and that the edges of the lids are glued together during sleep. In a short time, often within a few hours, the discharge increases greatly in quantity and changes in character; it first becomes mucopurulent, and ultimately, if the case is severe, is converted into almost pure pus. The eyelids now become red and swollen, and their tarsal margins caked together, so that the discharge accumulates behind the lids, and streams over the cheeks when the eyes are opened. The quantity of pus which literally pours from between the eyelids in a bad case, and the rapidity with which it is secreted, are very remarkable. The disease is most marked in the palpebral conjunctiva, which is reddened, swollen, and granular, so that it bleeds readily if touched.

In the *slight* cases of purulent ophthalmia the discharge is of a whitish colour with scarcely a tinge of yellow, and it is not very abundant in quantity. In the *very severe* forms of the disease the discharge is of a deep yellow colour and very profuse. Between these extremes there are many gradations. The constitutional disturbance is slight, so that if the lids remain gummed together the disease may exist for some days without attracting the attention of a careless nurse, and irreparable mischief result from the penning up of the purulent matter.

Prognosis.—When a child suffering from purulent ophthalmia is seen sufficiently early, and proper remedies are rightly applied, recovery is almost certain. It should, however, be remembered that cases occasionally occur of so severe a nature that all treatment is unavailable to arrest the progress of the disease, and one or both eyes are rapidly and irrecoverably destroyed. In such instances it will generally be found that the discharge was of a deep yellow colour, very copious, and that it commenced on the first or second day after birth. It will also be probably ascertained on inquiry that the mother had gonorrhœa at the time of her confinement, or leucorrhœa of so severe a type that the discharge was yellow and puriform.

The great danger in this disease lies in the spreading of the inflammation to the cornea. When this happens, acute keratitis follows; the cornea becomes at first hazy, then ulcerates either superficially or deeply, or, if the case be very severe, a large portion of it may slough. As the result of such casualties we get nebula, leucoma, or staphyloma of the cornea. Each of these subjects will be found fully discussed under their respective headings.

The conjunctival disease may on rare occasions be complicated by an inflammation about the joints analogous to the gonorrhœal rheumatism of adults. Clement Lucas* has recently drawn attention to this point and given a most interesting clinical report of twenty-three cases in which this complication occurred. In several of these the diagnosis was directly confirmed by aspiration and the discovery of

* 'Trans. Roy. Med. and Chir. Soc.,' vol. lxxxii, p. 137.

the gonococcus in the fluid withdrawn. The objective and subjective symptoms were typical, and with the exception of three cases in which suppuration occurred, all recovered completely within a few weeks. The joint inflammation was noticed usually between the second and third week, and its relative frequency did not seem to bear any relation to the severity of the conjunctival disease. That the complication is so rare Lucas thinks may be due to the fact that the conjunctival discharges usually obtain a free exit and are not pent up as is the case in gonorrhœal urethritis.

Treatment.—The indications for treatment are to wash away the discharge from the eye as often as it collects, and to use some astringent lotion to arrest the re-secretion of the purulent matter. The most useful lotions are the perchloride of mercury (F. 46), the chloride or sulphate of zinc (F. F. 54, 55), alum (F. 39), carbolic acid (F. 38), and quinine (F. 50), and personally we prefer them in the order named. The lotion should be employed every one or two hours, or even more frequently in some cases. It is better not to pin one's faith to any one lotion, but be ready to substitute another if it is not followed by rapid improvement. The mode, however, of applying the remedies is of as much importance as the remedies themselves. The lotion should be gently squirted into the eye with an india-rubber or small glass syringe, the india-rubber syringe having the advantage that the clumsy nurse cannot inflict injury on the eye with it so easily as with the glass syringe. This treatment should be pursued by night as well as by day, but with rather longer intervals. The intervals between the use of the lotion may be increased as the discharge decreases in quantity. The carrying out of these instructions should be entrusted solely to the nurse, as the mother, so soon after her confinement, is unfitted for the duty, and rest is also essential for her in order to ensure a due supply of milk for the child.

The easiest way of applying the lotion is as follows:—The nurse should lay the child on her lap, turning its head a little to one side or the other, according to the eye she is going to wash out. With the thumb and finger of her left hand she gently separates the lids, whilst with the right hand she squirts a stream of the lotion into the eye from the nasal side, allowing it to run away from between the lids on to a soft napkin, which she has placed under the child's head to receive it.

In some cases, where the nurse is very awkward and cannot rightly use the lotion with a syringe, it may be efficiently applied by means of a soft camel's-hair brush. From time to time a little Unguent. Cetacei or Unguent. Iodoformi (F. 68) should be smeared on the edges of the lids to prevent their sticking together.

In addition to frequent irrigation nitrate of silver should be used daily. If the case is a mild one it may be sufficient to place a few



FIG. 68. — Gutta-percha syringe for conjunctival irrigation.

drops of a solution of grs. ij ad ʒj twice or thrice daily between the lids but the more efficacious method is to brush the lids over once daily with a solution of grs. x to grs. xv ad ʒj, in the manner described on page 98. The child is most easily controlled for the purpose in the manner depicted in Fig. 69. If the œdema is too great to allow of eversion, the brush may be carefully passed under the closed lid and swept across the sac, taking care to keep it well pressed against the lid, so as not to touch the cornea; but in the worst cases when the tension and œdema are very great it is a good plan to divide the external canthi by a horizontal snip with scissors, after which, eversion will be effected much more readily. It is important that the silver solution should penetrate to the retro-tarsal fold of conjunctiva, so that when the upper lid is successfully everted the brush should be gently passed behind the upper border



FIG. 69.—A convenient method of holding the child to apply solution or drops to the conjunctival sac.

of the tarsus after brushing the tarsus itself. We have tried protargol in place of the nitrate of silver in several cases, but prefer the latter as more certain and speedy in its results. No bandage should on any account be applied to the eyes, or any form of dressing that can offer an impediment to the escape of the discharge. It occasionally happens, as an exception to this rule, that the upper lid becomes spasmodically everted, and a bandage may then be necessary after it has been returned to its normal position to keep it *in situ*; but the extra trouble entailed in replacing the bandage should not be allowed to interfere with the frequency of the irrigations. If the case is very obstinate, division of the external canthus will generally relieve the spasm of the orbicularis, and, if necessary, the lid may be united to its fellow for a few days by two sutures through the tarsal margins, after the conjunctival discharge has sufficiently diminished.

B. GONORRHOËAL CONJUNCTIVITIS.—*Gonorrhœal ophthalmia* is an acute specific inflammation of the conjunctiva of the lids and globe, induced by the inoculation of some gonorrhœal matter into the eye. It is characterised by a profuse purulent discharge from between the lids, which is of a yellow colour and exactly corresponds in appearance with that which flows from the urethra. The disease is rapid in its progress and very destructive; unless it is soon checked the eye is lost.

Symptoms.—Acute inflammatory action usually commences in from six to eighteen hours after the inoculation has been effected. The early symptoms resemble those of catarrhal ophthalmia, but they are more severe; a slight thin discharge first begins to ooze from between the lids, accompanied by a sense of heat and fulness of the eye. The conjunctiva of the globe grows red, swollen, and chemosed, often rising above the level of the cornea, which will appear as if it were partially buried below it. The lids are swollen, red, and shining, and completely closed over the eye. The discharge has now become excessive in quantity, of a thick consistence and yellow colour, and streams over the cheek from between the lids. The cornea is almost certain to become involved, and if the inflammation be not quickly subdued, ulceration and sloughing of its structure will surely follow. The patient suffers severely from the pain in the eye and around the orbit, with an oppressive feeling of heat and fulness of the lids and globe. The disease is usually confined to the one eye. When the second becomes affected it is generally on account of due precaution not having been taken to shield it from the danger of inoculation.

The most efficient mode of protecting the sound eye from contagion is by covering it with the eye-shield designed by Buller. The following is his description: "It consists of a square piece of mackintosh, into the centre of which a watch-glass is fastened, and of three strips of adhesive plaister. The mackintosh is trimmed to fit the nose and forehead of the patient, and should extend across one side of the forehead about half an inch above the eyebrow, and downwards nearly to the tip of the nose, the nasal portion reaching a little beyond the median line.

"A strip of adhesive plaister, about an inch in width, and long enough to reach from just in front of one ear to a corresponding point on the opposite side, is applied along the upper border of the shield. The second strip may vary in width according to the height of the nose, and must be snipped in three or four places, in order that it may be adapted to the uneven surface upon which it rests, the lower part

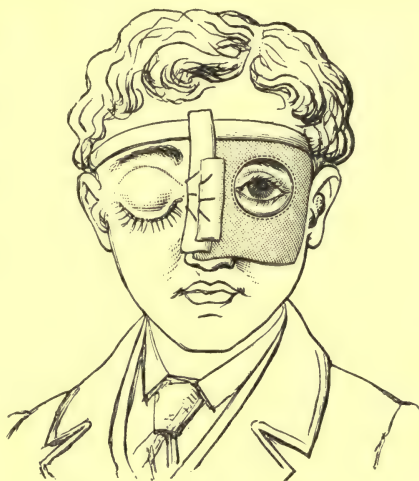


FIG. 70.—Buller's eye-shield.

only slightly overlapping the edge of the shield. For additional security, a third and somewhat shorter strip is placed along the dorsum of the nose. The eye is thus completely protected by a water-proof shield, the upper and inner sides of which are firmly adherent to the skin of the forehead and nose, whilst the lower and outer borders are free, so that the eye is exposed to the air almost as freely as when an ordinary shade is worn. Moreover, the surfaces of the watch-glass being parallel, vision is not interfered with, and the patient is able to attend to the affected eye.

"As the strips of adhesive plaster become softened in the course of a few days by the warmth and secretion of the skin they require to be renewed. This may be done as often as necessary without any difficulty or danger of infecting the healthy eye."*

Treatment.—A few years ago the treatment consisted in excessive bleedings from the arm, and in the use of strong depressing medicines. Experience has shown the error of such proceedings, and by now adopting a directly opposite course a far larger proportion of cases recover with good and useful eyes. In gonorrhœal ophthalmia the treatment must be constitutional and local.

Constitutional Treatment.—From the very commencement of the attack the strength of the patient must be supported by tonics, diffusible stimuli, and a liberal diet. The whole history of gonorrhœal ophthalmia is of a depressing character. The patient generally suffering from gonorrhœa at the time the eye becomes inoculated, is, from the nature of his complaint and the treatment adopted to cure it, below the standard of health. The disease itself is also very exhausting; but the prospect of loss of vision, with the utter annihilation of all future prospects, adds to his sense of loneliness and despair. The fact that the patient is suffering from a severe urethral discharge will not forbid the free use of tonics and stimulants. The danger of ulceration and sloughing of the cornea is increased in proportion as the vital powers are depressed. Having, therefore, first acted freely on the bowels by a moderate purgative, quinine in 2-grain doses or the mineral acids with cinchona should be given every four hours. If there is much pain or irritability, opium should be prescribed, either in small quantities frequently repeated, or in one full dose at bedtime. Where there is heat of skin, with thirst and a furred tongue, an effervescing mixture with ammonia may be ordered before prescribing the direct tonics. The diet should be one of meat or beef-tea, with a certain amount of wine or brandy, according to the strength of the patient.

Local Treatment.—The best applications are the local astringents and antiseptic lotions given below. In severe cases, owing to the swelling of the lids, it is very difficult to make any application to the conjunctival surfaces of the eye and lid. To remedy this, the external canthus may be divided, and the lid will then be more easily everted.

1. *Nitrate of Silver.*—This is best used in the form of solution, varying in strength from gr. x to gr. xx ad ʒj, according to the severity of the case. The lids should be everted and the conjunctival surfaces

* 'Lancet,' May 16th, 1874.

painted over with a camel's-hair brush with the solution, which should be allowed to remain a few seconds so as to whiten the parts, and be then washed off with a stream of cold water or boracic lotion (*see also* page 98). The application should be used once daily during the acute stages, but never oftener than this, and the frequency should be reduced as the congestion subsides. When the lids are so swollen that they cannot be everted, two or three drops of a weaker solution of nitrate of silver, from gr. ij to gr. v ad ʒj, may be dropped twice a day into the eye, after it has been first cleansed by syringing away the discharge.

In such cases of extreme swelling the application may be made by passing the brush, wet with the solution, under the closed lids in the manner described in the treatment of purulent conjunctivitis in infancy (page 104). This method, though more effectual, is neither so easy nor so safe in unpractised hands as the instillation of drops.

2. *Astringent Lotions.*—The same lotions as recommended in the treatment of ophthalmia neonatorum are equally useful here. As in the former case, the frequency of the irrigations must be regulated by the amount of the discharge, and in the acute stages will be required at least every two hours by day, with somewhat longer intervals at night. The irrigations must be thorough, and cannot be carried out by the patient himself. A capable nurse is an essential, and a small glass or india-rubber syringe, which can be easily disinfected, should be employed, care being taken always to syringe from the nasal side, so that no discharge is washed across the nose.

Cold is very grateful to the patient, and may be applied during the intervals between using the lotion by placing a fold of lint wet with iced water over the eyelids and changing it as often as it becomes hot or dry. The patient may also be allowed to wash away the discharge with a piece of linen dipped in the iced water as fast as it exudes from between the lids.

The application of a couple of *leeches* is often attended by much benefit. The pain and tension are relieved, and thereby the patient's general condition improved. They should be placed just external to the outer edge of the orbital margin, and the application may be repeated if necessary.

Should the cornea become hazy and ulcerated, atropine should be employed, and it is usefully combined with a little of the Ung. Iodoformi (F. 69) placed between the lids two or three times a day. The use of strong solutions or the electro-cautery is not to be advocated, as in sloughing ulcers unattended by purulent conjunctival discharge (*see* page 149), because we cannot hope, as in the latter, to remove the source of infection by these means, but rather tend to add to the necrosis.

The corneo-scleral margin is a place of danger if the conjunctival chemosis is so great as to overhang and conceal the margin of the cornea from view. For then a convenient receptacle exists where pus can readily stagnate unseen, and, if allowed to remain, it will speedily induce a suppurative keratitis.

It is not improbable that in a certain number of cases ulceration is promoted or actually caused by allowing the silver solution to flow unnecessarily over the cornea, especially when a very powerful solution

is employed or frequent application considered necessary. Due care should always be taken to avert this (*see* page 98).

By a steady perseverance in this line of treatment the best chance of saving the eye is afforded to the patient; but the disease is frequently of so virulent a character that, in spite of all remedies and the most judicious management, the cornea sloughs, and the eye, for all useful purposes, is irretrievably lost.

Prophylactic Treatment.—The surgeon, as a matter of routine, should warn every patient suffering from gonorrhœa of the danger of carrying the virus to his eyes. Scrupulous cleanliness, especially as regards the washing of the hands after attending to the urethra, must be insisted upon, and the towels and sponge used for the face must be kept apart from those employed for the body. The patient should also be warned not to wash his face in his morning bath, as he may easily do in a careless moment. These precautions should be rigorously enforced so long as there is any urethral discharge; for so long as this is the case, the gonococcus can always be found, even though all other signs of urethritis have long since disappeared.

The surgeon must also guard *himself* against infection from a gonorrhœal ophthalmia. Especially in syringing out the patient's eyes some discharge may readily spurt into the surgeon's face, and consequently both he and the nurse should always wear protectors made with white glass when attending to a patient. Should some discharge, by the neglect of this precaution, gain admittance into the surgeon's or nurse's eye, *immediate* steps should be taken to disinfect the eye by thoroughly washing it out with Hydrarg. Perchlor. gr. j ad ʒviij, or any other lotion if this is not available, and by dropping two or three drops of Argent. Nit. grs. ij ad ʒj between the lids.

Ophthalmia Occurring in Late Stages of Gonorrhœa.—There is a form of gonorrhœal ophthalmia consequent on the urethral discharge, but which is *not produced by inoculation*. The two eyes are affected simultaneously within a few days after the appearance of the gonorrhœa. It closely resembles a very severe attack of catarrhal ophthalmia.

We have notes of a man who had three attacks of this form of inflammation of the eyes, coming on each time shortly after he had contracted a fresh gonorrhœa. The purulent discharge from the eyes was at one time so copious that it seemed certain that it was caused by inoculation, but its reappearance in both eyes with each recurrence of the urethral discharge pointed convincingly to other causes, and further it is worth noting that this patient, with each attack of gonorrhœa, suffered severely from gonorrhœal rheumatism. It is possible that this form of ophthalmia may be due to the same absorption of the poison as that which induces gonorrhœal rheumatism, and that the discharge from the eyes is an attempt to eliminate the poison through the mucous surfaces of the globe and lids. Another explanation is, that in some people there exists a peculiar sympathy between the mucous membranes of one part of the body with those of another. Thus, it is not uncommon to find in a catarrh that the whole mucous lining of the body is more or less affected at one time, and in

one particular case which we can call to mind, a severe catarrhal attack is frequently accompanied by a discharge from the urethra.

Treatment.—The same as for the gonorrhœal ophthalmia caused by inoculation ; but as the symptoms are less severe, so the strength of the remedial applications to the eye may be reduced. Repeated doses of balsam copaiba will sometimes have a beneficial effect and check materially the purulent secretion. A good nutritious diet, with a moderate allowance of stimulants, should be prescribed.

FOLLICULAR CONJUNCTIVITIS.

The retro-tarsal fold of the conjunctiva is rich in adenoid tissue, which in children, especially in those of the strumous type, is apt to become hypertrophied when any irritation is set up in the conjunctival sac, producing the condition known as "Follicular Conjunctivitis." The activity of lymphoid tissue becomes less marked with advancing age, so that the disease is found chiefly confined to children and young adults, and is most common under the age of puberty. The patients, in a large number of cases, also suffer from naso-pharyngeal adenoids and enlarged tonsils, and the conjunctival manifestations, as Stephenson* has pointed out, are undoubtedly of a nature analogous to these.

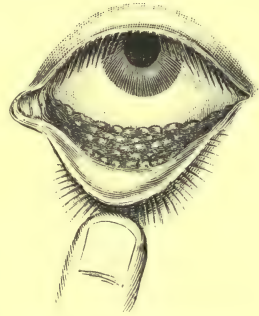


FIG. 71.—Inflammatory form of follicular conjunctivitis.

It will be gathered that, given the predisposition to lymphoid hyperplasia, the conditions under which Follicular Conjunctivitis may occur are many and various. They may all, however, be grouped into two main classes.

1. Inflammatory.—Any cause that is liable to produce catarrhal inflammation may equally act as an irritant to the lymphoid tissue, and follicular conjunctivitis is then only a modification of the catarrh. Consequently it is then contagious, and liable to occur in epidemics in schools, workhouses, or overcrowded and insanitary districts.

2. Non-inflammatory.—It is apt to follow upon the chronic congestion and irritation of the eyes set up by high uncorrected errors of refraction, particularly hypermetropia and astigmatism. This class is marked by the comparative absence of inflammation and discharge, and it is especially this variety that one finds so frequently associated with adenoids, swollen tonsils, and enlarged cervical glands. In some cases no cause can be assigned for the hyperplasia beyond the predisposition alluded to above.

Symptoms.—The hyperplasia commonly affects both eyes, and is confined to the retro-tarsal folds, where alone the lymphoid tissue is aggregated. That of the lower lid is chiefly, and in most cases exclusively, affected. Examination reveals horizontal rows of minute

* 'Epidemic Ophthalmia,' p. 125.

and discrete papule-like elevations, the size of which varies from a pin's head in some cases to mere raised points in others; whilst the *cul-de-sac* itself appears thickened, granular, and unduly prominent. In the inflammatory class there is, in addition, a good deal of obvious congestion, with flocculi of muco-pus and an accompanying inflammation of the palpebral and bulbar conjunctiva. The enlargement of the follicles is attended by a varying amount of discomfort, consisting of smarting and pricking, and generally by some photophobia and lacrymation; these subjective symptoms being much more marked in the inflammatory than in the non-inflammatory variety of the disease.

Diagnosis.—It used to be thought that follicular conjunctivitis was in some way connected with trachoma, to which it bears some superficial resemblance; but they are two totally distinct diseases, and must not be confused. It is best to leave the differential diagnosis until trachoma has been considered (*see* page 113).

Prognosis.—The condition, especially when not originating in an acute inflammation, is apt to become very chronic and troublesome; and many such cases drift on for years, now better now worse. Nevertheless, as growth progresses there is a decided tendency to improvement, and even the most obstinate cases get well in the long run. Follicular hyperplasia is unattended by any danger to the eye, and is never followed by cicatrization or contraction.

Treatment.—The catarrhal variety should be treated on the lines laid down for catarrhal conjunctivitis (*see* page 98), and the same precautions employed to prevent the spread of the disease to other members of the family or community.

The primary care in the second class of cases is the correction of the refraction; and, generally speaking, the glasses should be worn constantly for a time. They exercise a most beneficial effect and also shield the eyes from cutting winds. For outdoor wear it is often advisable to tint the spectacles to a moderate neutral hue to guard against extreme lights. Mild astringent lotions of zinc or lead (F. F. 55, 49) may be ordered for daily use, but they do not usually seem to be of great service, and of greater importance is the attention to the general health, especially as regards the removal of adenoids and enlarged tonsils. When the disease is a distinct local manifestation of a strumous diathesis, as in many cases it appears to be, much importance attaches to climate, clothing, and feeding; whilst from time to time courses of tonics should be prescribed, of which cod-liver oil, iron, malt extract, and the hypophosphites are the most useful.

TRACHOMA—*Granular Lids.*

This disease, which is known as the true granular lids, as opposed to follicular conjunctivitis, induces cicatrization of the conjunctiva, frequently leads to entropion, and is usually associated with a vascular condition of the cornea known as pannus. In itself trachoma is a very intractable disease, and the effects it produces on the cornea are often disastrous.

Trachoma commences as distinct new growths in the tissue immediately beneath the conjunctiva covering the tarsus of the lids. These appear as small, round, opaque, whitish bodies scattered in the conjunctiva of both the upper and lower eyelids, slightly projecting from the surface, and usually in the greatest numbers over the tarsus of the upper lid and the fornix. They are solid growths, and so firmly implanted that it is impossible to remove them, and when punctured they will not shell out from the subconjunctival tissue in which they are embedded. Histologically each *trachoma granule* consists in an aggregation of lymphoid cells resembling granulation tissue, and, like it, capable of being converted into contractile scar tissue.

Following the formation of these opaline bodies, plastic exudations infiltrate the subconjunctival tissue, and thus thicken the substance of the lid and reduce its pliancy. It is this thickened state which causes the lid to droop slightly and gives to patients with granular lids their peculiar sleepy and characteristic appearance. The palpebral conjunctiva itself next undergoes changes; it first becomes over-vascular, its papillæ are increased in size, and its surface is rendered still more uneven by the irregular projections of the submucous exudations.

The cornea now becomes roughened and hazy, having the appearance of ground glass, whilst at the same time new blood-vessels creep in between the epithelium and Bowman's membrane (*pannus*). The changes are first noted at its upper part, where the cornea comes in contact with the roughened surface of the upper lid, and thence it slowly spreads until the whole surface is opaque and vascular. That friction is the primary cause of the corneal symptoms is probable, but

it does not fully explain the origin of pannus, for the latter does not occur in all cases of trachoma, even when the conjunctival growths are numerous and prominent. There is in these cases a small-celled infiltration of the cornea which appears to be analogous to the conjunctival phenomena, but modified on account of the different structure of the former; and there are strong grounds for regarding pannus as trachoma of the cornea, which has become inoculated by some slight breach of surface induced by the friction between the lid and the cornea. The bulbar conjunctiva is never affected, probably owing to its loose connections, which minimise the danger of laceration and inoculation.

The trachomatous process is very chronic and may continue for years, but the time comes when reparative changes begin. The trachoma granules undergo retrogressive changes and finally disappear; the enlarged papillæ diminish in size and ultimately shrink from sight; the conjunctiva becomes glazed and contracted, and looks like cicatricial tissue. Whilst these changes are going on in the conjunctiva, a cica-

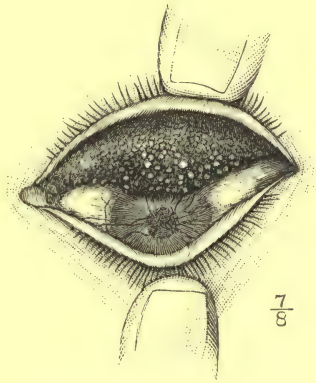


FIG. 72.—Trachoma, with Pannus.

tricial process also occurs in the subconjunctival tissue ; the increased thickness subsides, cicatrisation and contraction of the exudative products take place, and if the case has been severe, the tarsal cartilage becomes more or less infolded, and entropion results ; and this entropion increases so long as the contraction from cicatrisation continues. During the whole period of the disease there is a variable discharge from the conjunctiva, with some dread of light, and from time to time there are acute attacks of inflammation, when the eyes suffer from excessive photophobia with spasm of the orbicularis muscle.

Ætiology.—Trachoma appears clinically in two forms—the acute and the chronic. The acute variety is very rarely seen in Europe, but is endemic in Egypt, where it is fairly frequent. The chronic form, too, is now a comparatively rare disease in England, though frequently encountered in many other countries. The two varieties differ from each other in the intensity of the general inflammatory symptoms, which are very severe in acute trachoma, and in the character and quantity of the discharge, which is purulent and abundant in acute, but muco-purulent and in small amount in chronic trachoma. The gonococcus has been found in several cases classified as acute trachoma, and it would appear probable, in some instances at any rate, that the acute disease is simply an inoculation with purulent conjunctivitis of an eye affected with trachoma.

Trachoma is certainly contagious, for it appears in epidemics and spreads through communities ; but not eminently so, for when suitable measures for local disinfection and cleanliness are adopted, the disease is easily held in check, and, moreover, nurses and doctors in attendance on cases are seldom attacked. Undoubtedly its spread is facilitated by overcrowding and insanitary surroundings, and for this reason it is much more frequent among the poor than the well-to-do, and is especially common among the poor of certain races, such as the Jews and Irish. Further, as might be expected, trachoma assumes its most epidemic form in times of great national distress, such as a famine, when the conditions under which the poor live are probably at their worst. As to how the contagion is carried, the above considerations show that direct inoculation is the only probable method, and this is easily effected in communities by the common use of towels, etc. Kenneth Scott,* who has very large experience of trachoma in Egypt, says that direct infection can be almost always traced to direct manual contact—the rubbing of the eyes with the fingers, and the transmission of the virus to articles of daily work, and the inoculation of the hands of those who subsequently use such articles. Flies have been generally assailed as means of carrying infection, but Scott denies the accuracy of this supposition, pointing out that they seldom enter the conjunctival sac.

Very many attempts have been made to assign a *specific bacillary origin* to trachoma, but so far with no success. Great profusion of bacteria, both as to number and variety, is always to be found ; but in no case have the attempts to attribute a specific origin to any particular micro-organism been followed by satisfactory experimental proof. At

* 'Lancet,' ii, August 25th, 1900.

the same time it must be confessed that there is much in the character of the disease to warrant a belief in its bacterial origin, and it is possible that the difficulties of the case are best explained by the hypothesis of a mixed infection.*

Symptoms.—In *chronic trachoma* there is a feeling of constant grittiness and a sense of heat in the eye, with some photophobia, and a muco-purulent discharge sufficient to cause the lids to gum together in the morning. There is redness of the caruncle and tarsal margins, and in advanced cases the upper lid droops as if it hung heavily over the eye. When the cornea begins to suffer, the condition of the patient is much aggravated by the loss of sight entailed, though pannus does not cause any increase in the actual pain.

All these symptoms are greatly increased if the eyes are overworked, or exposed to cold winds or bright lights. Occasionally the eyes will become acutely inflamed; the lids are then red, swollen, and spasmodically closed from the excessive photophobia, and any attempt to open them is followed by a gush of hot tears, with some muco-purulent discharge. Under treatment these acute symptoms will gradually subside, and the eyes will again relapse into their previous state of chronic irritability.

In *acute trachoma* the symptoms assume a severe type. The inflammation is very violent, and there is a profuse purulent discharge. The especial danger is the ulceration of the cornea, and total loss of the eyes as a result.

• **Diagnosis.**—From follicular conjunctivitis trachoma is distinguished by the difference in the site of lesion, which in trachoma always includes the palpebral conjunctiva, a region devoid of adenoid tissue, and therefore not exhibiting granules in follicular inflammation. The upper lid especially is affected in trachoma, as against the lower lid in follicular disease. In the latter the granules are arranged in rows, not scattered irregularly as in trachoma, and the inflammation is never accompanied by pannus, nor followed by cicatrisation and contraction. Miliary tubercle, which may sometimes be confounded with trachoma, especially when there is no pannus, is distinguished by the growths being more patchy, and scattered in small groups; the retro-tarsal conjunctiva is frequently involved, and here tubercle is apt to be warty and papillomatous. The pre-auricular gland is always enlarged, and there may be other evidences of tubercle in the glands of the neck or lungs. If the cornea is affected the superficial patchy inflammation that attends tubercle will readily distinguish the disease from trachomatous pannus. In cases of doubt resort should be had to histological examination, and a search made for tubercle bacilli. Spring catarrh is another rare disease somewhat simulating trachoma. In the former the lid is uniformly covered with a densely set aggregation of flat-topped papules, hard, inseparable from each other, incapable of being expressed, and closely incorporated with the tarsus. In trachoma the growths are succulent, spherical, and irregularly distributed, and can be expressed. Here, again, if the cornea is involved the characteristic opacities of spring catarrh are quite unlike the pannus of trachoma.

* See article in 'Ophth. Hosp. Rep.,' vol. xiv, part 3.

The history of the case will also help the diagnosis, and the character of the discharge, which in spring catarrh is of a milky colour and of a peculiarly glutinous nature.

Prognosis.—Judicious management, coupled with the reparative power of time, will generally succeed in obliterating the granulations and restoring a smooth surface to the palpebral conjunctiva. If, however, the granules have been extensive and long-continued, they will probably have produced mischief which neither time nor remedies will ever completely eradicate. The *conjunctiva* will frequently become changed both in appearance and structure. Although its surface may have grown smooth, yet it will be more contracted and dense than formerly, and have acquired in different parts a whitish glistening aspect, closely resembling cicatricial tissue. This contraction of the palpebral conjunctiva is a frequent cause of entropion and trichiasis, and some permanent ptosis may also follow the thickening of the tarsus.

In the retrogressive stage the corneal vessels shrink and become avascular, but never entirely disappear. In mild cases the cornea may regain the greater part, if not the whole, of its transparency; but in long-standing and severe disease the vascularisation invades the true corneal substance, which is thereby permanently damaged, and persistent nebulæ of varying density will remain, which in the worst cases may render the eye for all useful purposes practically blind.

Two very serious complications of long-standing and severe trachoma are a slow bulging of the cornea (*Kerectasia*), and a *progressive* cicatrization of the conjunctiva (*Xerophthalmia*).

Treatment.—The intractable nature of the disease renders strong measures indispensable, but in employing the subjoined remedies we must be always careful to bear in mind the dangers of cicatrization, and not increase these by too frequent and violent procedures. The measures to be adopted consist in local caustic applications to the diseased surface calculated to destroy the granulations, and operative measures for their forcible removal. In mild cases the former treatment alone is needed, whereas in severe cases the two methods are advantageously combined.

A subsidiary but important point is the correction of the refraction. This is, of course, only applicable to cases of trachoma in which the cornea is still clear; but we have known several cases of this nature in which the symptoms were aggravated and kept up by high uncorrected errors of refraction. In every instance the wearing of correcting spectacles was followed by great improvement in the local condition, and by a much readier response to the other measures of treatment adopted. The reason of this lies in the increased vascularity and tendency to congestion that always accompany pronounced ciliary strain, and serve to accentuate the inflammation due to the disease itself.

In all cases lightly smoked protective spectacles should be ordered to shield the eyes from dust, wind, and glare.

Local Applications.—*a. Nitrate of Silver.*—This should be applied in the manner directed on page 98, and the solution should vary in strength from grs. x to grs. xx ad ʒj. The applications may be repeated every second or third day. When the granules are few in number the nitrate

of silver may be more conveniently applied by using the dilute nitrate of silver points (F. 5). Between the applications an astringent lotion of perchloride of mercury or zinc may be used two or three times daily. This is an excellent treatment for mild cases.

b. Perchloride of Mercury.—Kenneth Scott introduced this treatment with great success among Egyptian patients, and we have found it an admirable one in severe cases; but it causes much more pain than the nitrate of silver. The application is made in the same way as the latter, and a 2 to 4 per cent. aqueous solution is used, which is made by dissolving the salt in glycerine and adding water. Scott's method is to make the applications daily, unless there is much resultant œdema of the lids, when an interval of one day is allowed. We have found excellent results with the application repeated twice weekly. As the granulations subside the solution should be gradually weakened. Drops of the same drug of a strength of $\frac{1}{8}$ to $\frac{1}{4}$ per cent. may be used in addition if considered necessary, and a cooling lotion prescribed with which to wash the eyes out at intervals.

c. Sulphate of Copper, or a combination of this salt with alum, "lapis divinus," or "greenstone," as it is commonly called (F. 4), are excellent astringents in granular lids. Every second or third day the lid should be everted, and having first dried the surface with a piece of linen, the granulations *only* should be freely touched with the sulphate of copper or greenstone, taking as much care as possible to prevent the caustic from affecting the conjunctiva. Between the applications a few drops of the Guttæ Cupri Sulphatis (F. 13) should be dropped twice a day into the eye.

d. Acetate of Lead is a useful remedy when there is excessive roughness from the whole palpebral conjunctiva being covered with red granulations of varying sizes, but unattended by any acute inflammatory symptoms. The acetate of lead should be finely powdered and laid over the granulations, and, after waiting one or two minutes, the surplus should be washed off with a stream of cold water. This application does good; first by rendering the surface more smooth by filling up the chinks between the granulations, and afterwards by its astringent powers causing them to shrink. It may be repeated at intervals of from three to six days. This form of treatment must never be used if there is any ulceration or roughening of the cornea.

e. Lightly touching the granules with the galvano-cautery is a method that is often attended with excellent results. The cautery must only touch the granulations themselves, and must not be allowed to penetrate deeply. The application may be repeated as necessary with an interval of five to ten days. It is best to touch only a limited number of granules at each sitting.

Note.—When the inflammatory symptoms are very acute it is wiser to abstain from all strong astringent methods until they have somewhat subsided by the application of warmth and moisture.

Operative Treatment.—1. *Expression.*—This is the best of all operative procedures, as it does not involve the loss of tissue and so encourage the formation of cicatrices. The lid is everted and one blade of Graddy's or Knapp's roller forceps is passed behind the lid into the fornix, whilst

the other rests against the palpebral surface. By a combination of pressure and traction the forceps are forced over the granulations, squeezing out their contents. The whole surface of the lid is thoroughly expressed between the blades of the forceps. Solid cocaine crystals or a general anæsthetic are needed, as the application is very painful.

2. *Grattage*.—After scarification, a solution of Hyd. Perchlor. (1 in 1000) is well scrubbed into the conjunctiva with a hard brush. This presents no advantage over expression, and there is danger of adding to the cicatrix.

3. *Excision of the Fornix Conjunctivæ*.—This measure has been practised when the granulations have been very abundant in this situation. It is not to be recommended except in the severest cases on account of the loss of tissue entailed.

The treatment of long-standing and severe pannus which is causing great loss of sight needs special mention. In former days it was usual to inoculate such an eye with pus from a case of gonorrhœal conjunctivitis; but the obvious dangers of this treatment need not be insisted upon, and a less severe method has taken its place in the inoculation with infusion of jequirity, which produces a purulent inflammation sufficient to destroy the pannus, and is more easily controlled. The infusion must be made fresh (F. 27), and should be rubbed well over the everted lids. The cases suitable are those in which the whole or certainly two thirds of the cornea is semi-opaque and no ulceration is present. The resulting conjunctivitis must be allowed to run its course unchecked, a careful watch being kept on the cornea in the meantime, and the other eye protected from contamination by a Buller's shield (Fig. 70). Should the cornea become ulcerated, means must be taken to arrest the inflammation. The proceeding is not devoid of danger, but the results in successful cases are very gratifying in the improvement of the vision.

Section of the vessels surrounding the cornea has been frequently practised in the operation of "**Peritomy**," by which a narrow circular band of conjunctiva and subconjunctival tissue is dissected off close to the cornea. The operation has lately been more neglected than it deserves, for, although uncertain, it is sometimes followed by much improvement. Kenneth Scott* has found much benefit in gently slitting up the larger corneal trunks *longitudinally* with a small Graefe's knife, and thus converting them into open gutters.

Prophylactic Treatment.—Strict disinfection of towels, pillows, and hands should be practised, as detailed in other forms of epidemic conjunctival inflammation, and all due precautions taken for isolation in crowded communities, such as schools. In hospitals the materials, brushes, etc., used for applications should be kept strictly apart, and only employed for cases of trachoma.

MEMBRANOUS CONJUNCTIVITIS.

There are two distinct clinical varieties of conjunctival inflammation which are accompanied by the formation of a false membrane.

* 'Lancet,' ii, August 25th, 1900.

Pathology.—In the one, *croupous* or *pseudo-diphtheritic conjunctivitis*, the membrane simply consists of a layer of coagulated exudation superficially attached to the subjacent conjunctiva; in the other, *true diphtheritic conjunctivitis*, the membrane presents the characters found in diphtheria elsewhere, and consists of a definite necrosis of the conjunctiva, with which it is therefore incorporated and cannot be detached. In its simplest form a coagulation membrane is simply an expression of an intensely severe inflammation, and it is thus often seen in bad cases of catarrhal and purulent conjunctivitis; or it may be artificially produced by the too liberal application of strong caustics to an inflamed conjunctiva. There is, however, in addition a special form of conjunctivitis, to which the term "*croupous*" is particularly applied, which is characterised from the outset by an extensive formation of this coagulation membrane, and which is sometimes difficult to differentiate from true diphtheritic conjunctivitis. Both on the grounds of public health and treatment a correct diagnosis is a matter of considerable importance.

In a certain number of cases a diagnosis of diphtheria of the conjunctiva can be made clinically without a shadow of doubt by the well-marked characters of the inflammation, aided by general symptoms, and perhaps by the location of diphtheritic membrane in the fauces, vulva, etc. With equal certainty diphtheria can often be definitely excluded by the clinical symptoms; but there still remains a class of cases in which the symptoms are atypical; when the clinical features are on the borderland, as it were, between the croupous and diphtheritic types. The diagnosis in such cases must be concluded by bacteriological examination for Klebs-Loeffler bacilli, which will always be found in true diphtheria. The importance of such an examination is enhanced, because it is well known that the *pathological lesions* caused by these bacilli may be much modified under certain conditions; and it is by no means a very rare thing to find that Klebs-Loeffler bacilli are present in a membranous conjunctivitis, the characters of which partake rather of the croupous than of the diphtheritic type. There is, however, a very possible fallacy in a bacteriological examination, due to the Xerosis bacillus, which morphologically is almost identical with the Klebs-Loeffler bacillus, though absolutely non-pathogenic. We are personally of strong belief that many mistakes have been made in diagnosis owing to this fact, and it is therefore of the greatest importance that the examination should be conducted by an *experienced* bacteriologist.

CROUPOUS CONJUNCTIVITIS.—The disease is confined to children, and may affect one or both eyes. The lids are red and swollen, and gummed together by yellowish discharge, which oozes out as they are parted. On eversion the upper lid in particular is found to be coated with a smooth white or whitish-yellow membrane, which is easily detached with forceps, exposing a raw, bleeding surface, rough and granular, but showing no loss of substance. The membrane is composed of leucocytes and fibrin, and often attains considerable thickness (1 mm.). Fresh coagulation speedily occurs, so that within an hour,

as we have known it, the conjunctiva is once more completely covered by a new formation. After a few days of treatment the formation of membrane gradually diminishes, its place being at first taken by an increase in the muco-purulent discharge, and the case then assumes the appearance of, and runs a course similar to, an acute muco-purulent conjunctivitis. In the membranous stage the disease is a dangerous one, and threatens the integrity of the eye, the more particularly because it is unamenable to the astringent form of treatment suitable to simple muco-purulent inflammation. The constitutional symptoms may be sometimes severe, but they vary considerably. The pre-auricular gland is occasionally enlarged.

DIPHThERITIC CONJUNCTIVITIS.—The conjunctival affection may be primary or secondary to diphtheria of the fauces or nasal fossæ. We have known two cases in which it followed upon diphtheritic vulvitis, being probably directly inoculated by the fingers. Like the croupous inflammation, conjunctival diphtheria seems to be confined to children. It commences suddenly; the lids are red and swollen as in the croupous variety, but in addition they are brawny and stiff from fibrinous infiltration. There is chemosis of the ocular conjunctiva, not from serous effusion as in purulent ophthalmia, but from fibrinous infiltration; and a thin discharge, mixed with flocculi of lymph, oozes from the eye. As the disease advances, the swelling and redness of the lids increase, and exudations of lymph take place on the surface and into the substance of the conjunctiva of the lids; and are seen on eversion, either as small isolated grey patches or else as a continuous membrane. This membrane may sometimes be partially peeled off, when the conjunctiva beneath it bleeds; or more frequently only the superficial layers of lymph can be detached, and the deeper portion is seen to be incorporated with the mucous membrane and incapable of separation.

The cornea is very apt to suffer, probably from the constriction of the vessels caused by the fibrinous infiltrations into the conjunctiva and subconjunctival tissues. It first becomes hazy, portions of its epithelium are detached, and an ulcer is formed, which may lead to perforation and prolapse of the iris; or parts of the cornea may slough and the eye be destroyed. After a variable period, generally from two or three days to a week, the disease drifts into its second stage; the lids become less rigid, the redness subsides, and the discharge becomes purulent; the fibrinous exudations are thrown off, and the conjunctiva of the lids appears bared of its epithelium. Cicatrisation and contraction now set in, and not unfrequently cause some inversion of the lids. A progressive cicatrisation (Xerophthalmia) is sometimes induced in the worst cases.

Constitutional symptoms vary a good deal. In most cases the child is very markedly ill, but fatal cases of primary diphtheritic conjunctivitis are very rare. The pre-auricular gland is enlarged, and sometimes the cervical lymphatic glands as well. Albuminuria is a frequent, but not constant symptom. Muscular pareses occasionally occur during convalescence.

Treatment of Membranous Conjunctivitis.—In cases of doubt as to the differential diagnosis, prophylactic measures should be taken at once, without waiting for the bacteriological report. The child should be isolated, and the sound eye protected by a Buller's shield (Fig. 70). With the numerous laboratories scattered throughout the country a confirmatory report can generally be had within twenty-four hours, and if the case prove to be one of diphtheria, antitoxin injections into the buttock should be commenced at once, the dosage and frequency depending upon the case. In well-marked diphtheritic cases antitoxin should be employed at once without waiting for the report, and the same course is prudent in doubtful cases, if from any cause the report is likely to be delayed. Antitoxin has answered very well in several cases of primary conjunctival diphtheria, the local symptoms quickly improving under its use.

In both croupous and diphtheritic conjunctivitis all astringent applications must be avoided during the membranous stage, and, indeed, in diphtheritic conjunctivitis with its tendency to form cicatrices they are best avoided at all stages except in very weak solutions. A most successful local application in the acute stages is that first introduced by Tweedy,* and consists in frequent gentle irrigations with quinine lotion (*see* F. 50), which acts as a very efficient non-irritating germicide. Simple coagulation membrane may be removed once or twice daily provided that it is easily detached, and the inflamed conjunctiva then gently dabbed over with the lotion. No attempt should be made to tear away membrane that is firmly adherent. In the croupous variety the case should be treated on the lines of an ordinary acute muco-purulent inflammation as soon as the membrane has entirely disappeared, but caution must be exercised at first not to use too strong astringent solutions.

During the convalescent stage of diphtheritic inflammation care must be taken to limit the extent of cicatricial formation as much as possible, by daily eversion of the lids, the separation of opposing raw surfaces, and the use of emollients, such as "toilet lanoline." If the cornea becomes involved in diphtheritic inflammation the eye will probably be lost. The best chance lies in the speedy relief of the conjunctival condition, and in no case should resort be had to strong local applications, such as the cautery, to arrest the ulceration; for they will only make matters worse by increasing the necrosis.

In the convalescent stages of membranous conjunctivitis a course of tonic treatment should be employed; and in diphtheritic cases the child should be kept constantly in bed until all danger of cardiac failure has passed.

TUBERCULOSIS OF THE CONJUNCTIVA.

This is a rare disease usually confined to childhood and adolescence, but occasionally occurring in adults. It is usually limited to one eye, and is characterised by its intractable nature and liability to recurrence. The site of election is the upper lid, though any portion

* 'Lancet,' 1882, vol. i, p. 6.

of the conjunctiva may be attacked. On the tarsus the disease generally takes the form of miliary nodules, either scattered discretely over the surface, when they may attain considerable size, or collected together in aggregations or raspberry-like clusters of minute seed-like growths. The retro-tarsal fold is also a favourite spot, and here the growths frequently assume an exuberant character and appear as warty, vascular excrescences. After a time the miliary nodules tend to caseate and break down, forming ragged ulcers, and at this stage the cornea is apt to become hazy and ulcerated from friction against the roughened lid. In the first instance there is little surrounding inflammation, and the subjective symptoms are slight; but when ulcers appear there is much general irritation of the conjunctiva, which is thickened and granular, and photophobia, lacrymation, pain, and a muco-purulent discharge make their appearance. These symptoms are still further aggravated if the cornea becomes involved. The pre-auricular gland is always enlarged and sometimes tender.



FIG. 73.—Tuberculosis of the conjunctiva.

The disease, though sometimes associated with other evidences of tubercle, such as enlargement of the cervical lymphatic glands, is, in many instances, a primary focus of tubercle. It has also been observed as a sequela of lupus of the face.

Diagnosis.—Trachoma is the disease most liable to be confounded with tuberculosis, especially when there is much inflammation of the surrounding conjunctiva and a muco-purulent discharge. The differential diagnosis has already been mentioned in treating of trachoma (page 113). Histological examination of the growths will reveal typical giant-cell systems, and in many cases tubercle bacilli themselves can be found with care.

Treatment.—The efficient treatment of conjunctival tuberculosis becomes of the first importance if the disease is a primary focus, for its thorough elimination may be the means of preventing the spread of the disease to other parts of the body. When possible the whole of the diseased area should be completely excised, and it is remarkable

what an extensive operation can be done in this way without causing subsequent serious contraction or limitation of movement. When the tarsus is extensively infiltrated throughout, this treatment becomes impossible, and then free scraping with a sharp spoon should be employed, and repeated upon the slightest sign of recurrence. After each scraping it is a good plan to rub the raw surface well over with iodoform. The enlarged pre-auricular gland should also be excised.

Constitutional treatment is of importance, as in all cases of tubercle, and cod-liver oil or the hypophosphites should be ordered. Attention should also be paid to clothing, diet, etc., and during convalescence the patient despatched for a time to a dry, bracing climate.

PEMPHIGUS OF THE CONJUNCTIVA.

This is a severe, but fortunately a very rare affection. The bullæ appear on the conjunctiva of the lids and eye, whilst the pemphigus blisters are coming and going on other parts of the body. The formation of the bullæ is accompanied by swelling of the lids, chemosis of the conjunctiva, and a muco-purulent discharge. The bullæ speedily rupture, on account of the extreme delicacy of their walls, so that in many cases it is only possible to assume their previous existence by the presence of resulting ulcers. The latter form the great danger of the affection, for the raw surfaces unite at opposed points and form adhesions which bind the lids to the globe (*symblepharon*), and sometimes the margins of the lids to each other (*ankyloblepharon*). If the surface of the cornea has been involved in one of the bullæ, it loses much of its transparency, assumes a fibrous aspect, and probably becomes united by bands of adhesions to the inner surface of the lids. When pemphigus has once attacked the conjunctiva the bullæ may reappear from time to time, and a slowly progressing cicatrisation is set up, by which the eye is entirely lost. The whole structure of the conjunctiva becomes gradually altered in this way, and assumes the appearance known as xerosis, which is described in dealing with that affection.

Diagnosis.—There is not much difficulty when the eye affection is associated with pemphigus of the body, as is most often the case. When the conjunctival inflammation is primary the diagnosis is made by the formation of recurring ulcers and progressive cicatrisation of the conjunctiva. As already explained, one must not expect in most cases to see the bullæ themselves.

Treatment.—This is very unsatisfactory. Astringents do no good. The use of ointments is sometimes attended with relief; and lanoline, in the form of toilet lanoline, is perhaps the best, and has answered well in our experience. The only form of treatment which is likely to be attended in advanced cases by anything more than temporary benefit is the relief of contraction by dissecting the palpebral conjunctiva from the lids and covering the raw surface of the latter with an ample Thiersch graft. In most cases where this has been tried the result has not fulfilled expectations; but we have had a bad case of pemphigus with very acute shrinking of the conjunctiva in which the Thiersch graft was

most successful. Two years after operation there had been no recurrence of symptoms, the ocular surfaces of the lower lids were clothed with skin, and the corneæ bright and clear. The difficulties in the way of success lie chiefly in keeping the graft at rest and in proper apposition. These may be overcome by passing some fine silk sutures through the lid across the graft to hold it in place, afterwards uniting the lids together for at least a week, until the graft has taken firm hold. The first suture should be passed through the free margin from without inwards, close to the canthus, then across the graft diagonally, and finally bringing it from within outwards on to the skin surface at the lower border of the lid about halfway along its length. The second should be passed in a similar way, only it should start at the lower border of the lid opposite the point of entrance of the first suture, and be brought out at the free margin opposite the point of exit of the first suture. A third and a fourth suture may then be employed over the other half of the lid in a precisely similar manner. The sutures should pass through the lid-structures only, and not through the graft, which is bound in place by the lattice-work arrangement of the sutures. The free skin terminations of the sutures may be then loosely tied over a piece of rubber tubing, and finally the upper and lower lids are united by a few points of suture.

Phlyctenular Conjunctivitis (*see* "Cornea," page 156).

Conjunctivitis Secondary to Acne Rosacea (*see* "Cornea," page 160).

The corneal lesions in these diseases being their most serious features, it is thought best to classify them under "Diseases of the Cornea."

AMYLOID DEGENERATION.

This disease is unknown in this country, and is chiefly confined to Russia. It consists in great hypertrophy of the adenoid elements of the subconjunctival tissue, accompanied by colloid degeneration and the formation of homogeneous hyaline bodies. It usually begins in the retro-tarsal folds, and spreads thence to the conjunctiva of the lids and globe. There is great chemosis of the conjunctiva, which is protruded in soft, waxy-looking folds, with swelling and distortion of the lids, which by their increased weight hang over and conceal the eyes from view. The disease is unaccompanied by subjective symptoms or signs of inflammation, the swellings being, indeed, notably avascular. It is very chronic, and may extend over several years, but shows no tendency to affect the integrity of the eye. It is said in some cases to arise as a sequela of trachoma, but in others it appears to be a primary disease. Persons of middle age are those most usually attacked, and both eyes may be affected.

Treatment.—The disease is unamenable to any but operative treatment. Portions of the thickened protruding tissue may be removed, so as to allow the patient to voluntarily open the lids.

VERNAL CATARRH—*Spring Catarrh*.

This is a chronic disease of the palpebral and ocular conjunctiva rarely seen in this country. Both eyes are affected and the

patients always youthful. In a well-marked case the palpebral conjunctiva is covered by flat-topped papules, so closely set that the tarsus appears tessellated, or, as Fuchs* describes it, "like a cobble-stone pavement." The growths are of cartilaginous hardness and closely incorporated with the subjacent tarsus, so that they cannot be expressed, and the conjunctival epithelium, which is surmounted by a slight glutinous secretion, has a peculiar opalescent appearance, generally described as "milky." On the bulbar conjunctiva the lesions are confined to the limbus of the cornea, and consist of reddish-brown or grey nodules of a characteristic fleshy appearance, which overhang the corneal margin and may trespass on its substance. Either the typical palpebral or bulbar lesions may be absent in any case, but the peculiar opalescent condition of the conjunctiva and the transparent glutinous secretion are almost always present. The growths, when once established, show little tendency to increase or disappear, and consequently the disease lasts for years. It, however, is subject to exacerbations in the spring and summer which die away in autumn and winter, and from this peculiarity it has received its name. During these exacerbations there are well-marked subjective symptoms consisting of itching and photophobia, and there is also some muco-purulent discharge; but in the quiescent periods of winter these are very much diminished.

Pathology.—The causation of this disease is not known. It is certainly not epidemic, and has apparently no specific origin. The growths are fibrous in texture, and are composed of connective tissue surmounted by a greatly proliferated epithelium, which gives to the palpebral conjunctiva its characteristic opalescent appearance (Fuchs). The disease is not followed by any cicatrisation.

Diagnosis.—Trachoma is the only disease liable to be mistaken for it. The history of yearly exacerbations in the spring; the curious bulbar growths unlike anything seen in trachoma; the hard flat-topped papules covered with the bluish epithelium, which cannot be expressed or removed; together with the absence of pannus and the severe catarrhal inflammation that attends trachoma will serve to distinguish the two diseases.

Prognosis.—The disease may last many years, but tends to gradually disappear; for it is very rarely seen in adults.

Treatment.—This is purely palliative. The applications of caustics and strong astringents are not followed by the slightest benefit, and only aggravate the subjective symptoms. The same applies to any attempt at a radical operation, such as expression of the conjunctival papules, which should not be undertaken. Simple cooling lotions of carbolic or boric acid (F. F. 37, 38) should be ordered, which give especial

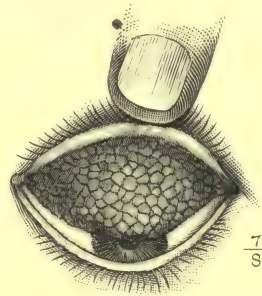


FIG. 74.—Vernal catarrh.
From a case under the
care of the author.

* 'Text-book of Ophthalmology,' 2nd edit., p. 104.

ease if a weak solution of cocaine (gr. $\frac{1}{2}$ ad $\overline{3j}$) is added, by which the itching is relieved. Dark protecting glasses should also be ordered for outdoor wear to shield the eyes from dust, wind, and glare. If the child is weakly, attention should be paid to improving the general health by tonics, etc. We have also seen very marked benefit to the corneal lesions derived by gently massaging the eyes with a 2 per cent. preparation of the Unguent. Hyd. Ox. Flavi.

XEROSIS—*Xerophthalmia*.

The disease exists in two forms:—(1) *Parenchymatous Xerosis*.

(2) *Epithelial Xerosis*.

The main feature in both is a metamorphosis of the conjunctiva, whereby it becomes dry, dull, and insensitive. The epithelium becomes horny, opaque, and flakes off, and the tears no longer adhere to it. In parenchymatous xerosis there is in addition a shrinking of the subepithelial layers and the formation of cicatricial bands.

I. PARENCHYMATOUS XEROSIS, sometimes known as *Essential Shrinking of the Conjunctiva*, may be (a) *Primary* or (b) *Secondary*.

a. **Primary.**—This is a rare disease affecting both eyes, and generally seen in people past middle life. It arises without apparent cause, is accompanied by no inflammation and no subjective symptoms

beyond slow progressive loss of sight. The lack-lustre appearance of the eyes at once engages attention, and on making traction on the lids cicatricial bands are seen to be passing from the lids to the globe, obliterating the *cul-de-sacs* and inverting the tarsus (entropion), so that the lashes brush against the eye. In still more advanced cases the corneal epithelium shares in the degenerative process, and the cornea becomes gradually opaque and covered by a whitish wrinkled film much resembling skin in appearance (*see* Fig. 75). The contraction slowly progresses until the lids are bound down to the globe (*symblepharon*), the movements of the eyeball

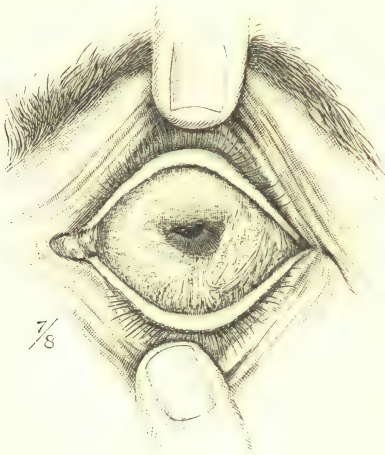


FIG. 75.—Parenchymatous xerosis of the conjunctiva in its later stages.

abolished, the sight totally destroyed, and the whole conjunctival sac converted into a shrunk desiccating membrane over which the lids refuse to meet, and through which the eye appears as though pushed back into the orbit.

b. **Secondary.**—The disease in this case is developed in the cicatrices formed after pemphigus, diphtheritic conjunctivitis, burns,

and trachoma. In its clinical features it much resembles the primary variety, but it may for long be limited to the region of the cicatrices, and the cornea meanwhile remain unaffected. Eventually, however, the cicatrization is apt to extend, and then sight will be lost in the manner above described. Another point of difference is that the process is sometimes accompanied by a chronic inflammatory condition, and the bulbar and palpebral conjunctiva is reddened and chemosed.

Treatment.—Parenchymatous xerosis is very unamenable to treatment, and progresses steadily from bad to worse. Lotions of all sorts are quite useless. Glycerine, which has been advocated, is worse than useless on account of its dehydrating qualities. Grease in some form seems to give the most relief, and we have obtained marked benefit by massaging the conjunctival sac through the lids with toilet lanoline. In one case this treatment was pursued for five months, and no apparent advance in the disease was made during that time. Suturing the lids together, leaving a small aperture for vision, has been tried, and improvement has followed during the exclusion, but the disease returns on reopening the lids. The separation of the lids from the globe by dissecting off the conjunctiva and the insertion of a skin or mucous graft has been tried several times, but usually without any lasting benefit. One successful case, however, in which this treatment was adopted is mentioned under “Pemphigus,” where, also, some remarks are made as to the performance of the operation (*see page 121*).

2. EPITHELIAL XEROSIS.—Here the changes are limited to the epithelium, and consequently there is no cicatrization. There is the same dull, dry appearance of the conjunctiva, and over the line of the palpebral fissure there generally appear little frothy-looking patches where the epithelium is raised and desiccating, whilst to the tarsal borders of the lid there clings a characteristic white soapy secretion composed of epithelial *débris*. Epithelial xerosis is always accompanied by night-blindness (“Nyctalopia”), and both are purely symptomatic evidence of a general malnutrition. It is the nyctalopia that brings the patient, and he is probably not cognizant of the conjunctival condition. The patients are usually children, half starved and neglected; but a similar train of symptoms is sometimes observed in sailors who have been long confined on board a sailing ship with restricted and improper diet.

Epithelial xerosis also occurs in “*Keratomalacia*.”

Treatment.—The patients usually rapidly recover if proper diet be administered, in which fresh milk and vegetables should play an important part. In addition, cod-liver oil and malt extract are useful remedies. The ingestion of raw ox liver, of which the patient eats $\frac{1}{4}$ to $\frac{1}{2}$ lb. daily, is an old Eastern remedy for nyctalopia which is said to be very successful, but which has only recently come under European notice.* Major Buchanan, I.M.S., speaks very highly of it,† and employs goat’s liver fried with oil and spices.

Xerosis Bacillus.—Large numbers of these bacilli, which bear a

* Trantas, ‘Recueil d’Ophthalm.,’ July, 1899.

† ‘Ophthalmic Review,’ vol. xix, p. 360.

strong morphological resemblance to Klebs-Loeffler bacilli, are found in the conjunctival sacs in this disease, and received this name upon the supposition that they were the specific cause of the lesions. The bacillus is, however, perfectly inert, and is a constant normal inhabitant of the healthy conjunctival sac.*

PINGUECULA.

This is a term applied to a small yellowish patch which is frequently seen near the margin of the cornea in the middle line, and has received its name on the erroneous supposition that the yellow colour was due to fatty changes. It is really a small overgrowth of conjunctival epithelium, the result, like epithelial hypertrophy elsewhere, of chronic irritation. It only occurs in the line of the palpebral fissure, where the eye is unshielded by the lids, and is most common in those who have been long exposed to irritating atmospheric influences, such as seamen, coachmen, etc. The patients are usually middle-aged or old, and the patch is frequently bilateral, both as regards the cornea and the two eyes.

A pinguecula is of no pathological importance except that it may possibly be the forerunner of a pterygium, and it causes no discomfort.

No treatment is required. Any attempt to remove pingueculæ by caustics would probably result in the formation of a still more conspicuous scar, which might also become keloid. If the little patch really worries a nervous patient it may be removed with a pair of fine scissors, and a conjunctival suture inserted to approximate the cut edges.

PTERYGIUM.

Pterygium, so called from its resemblance to a wing in shape (Fig. 76), is a peculiar morbid growth of the conjunctiva and sub-conjunctival tissue. It is of a triangular shape, with its base usually at the semilunar fold close to the inner canthus; and extending outwards it gradually tapers to a rounded end or head, which is implanted on the surface of the cornea, generally reaching to a point opposite the inner margin of the pupil, sometimes spreading halfway across it, but never completely occluding it.

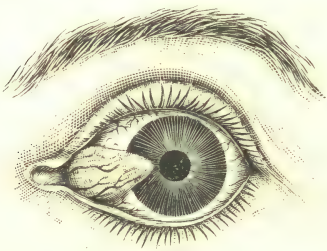


FIG. 76.—Pterygium.

A pterygium is more or less vascular, and one or two large conjunctival vessels may be frequently seen coursing along it. In some cases, mostly recent and progressing cases, it is red, fleshy, and prominent, whilst in others it is pale and membranous, and so thin as to be almost translucent.

A pterygium is almost invariably a single growth confined to the

* "Bact. of Healthy Conj. Sac" (Lawson), 'Trans. Jenner Instit.,' vol. ii, p. 56.

inner half of the eye, although to this there are occasional exceptions, and cases have been reported where there have been two pterygia, one on each side of the cornea, and also where they have occurred in the upper and lower parts of the eye, in lines corresponding to the superior and inferior recti muscles. The disease may be limited to one eye, or both may be affected by it. We have seen many cases in which a pterygium existed in both eyes; in all of them the growths were symmetrical.

Patients about the middle age are most liable to pterygium, and especially those who have served long in tropical climates and those who have been long exposed to dust, wind, and weather. It is seldom if ever seen in the young. The disease tends to grow slowly and almost imperceptibly for years, but never spreads, as already said, beyond a certain point, when it becomes stationary. It is not until it has attained a considerable size or interferes with vision by trespassing on the area of the pupil that it usually causes any serious annoyance.

Ætiology and Pathology.—A pterygium consists essentially of a localised vascular overgrowth of the fibrous element of the subconjunctival tissue, surmounted by the conjunctival epithelium, which at the head of the growth merges into that covering the cornea. The union between the head and the subjacent cornea is very firm, and extends into the superficial true substance of the cornea, so that some opacity always remains at the site of the head after the pterygium has been removed.

The exact causation is not understood. Fuchs* looks upon a pterygium as identical in origin with a pinguecula, of which it is an extension over the cornea. It is certain that the same combination of causes predisposes to both affections. It has been attempted to explain the origin by presupposing a marginal ulcer into which a fold of the conjunctiva has become caught, and that cicatricial contraction of the included fold accounts for the growth of the pterygium. This theory is, however, scarcely tenable (see "*Pseudo-ptyerygium*"). The growth of the pterygium horizontally across the cornea is doubtless due to its naturally following the line of the palpebral fissure, where the eye is most exposed to the irritating effects of dust and wind. The frequency with which it is found on the nasal side of the eye may perhaps be explained by the tendency for irritating particles to collect here, being washed across by the tears.

Treatment.—There is no object in interfering with a small pterygium which is not causing discomfort, unless its removal is desired for cosmetic reasons. There are only two ways of efficiently dealing with a pterygium. It may be excised, or its apex may be transplanted from the cornea to a part of the conjunctiva where, even if it were to grow, it would cause no impairment of vision. No local application to the eye will be of any benefit in eradicating the growth, and half-hearted measures, such as excision of the head alone, will probably be followed by a recrudescence of it.

1. Excision of the Pterygium.—The lids being separated by a spring speculum, the pterygium is to be seized from above downwards by a pair of forceps and drawn slightly from the eye. With a pair of fine scissors or a Beer's knife its attachment to the cornea is to be

* 'Text-book of Ophthalmology,' 2nd edit., p. 114.

separated, and then with a few snips of the scissors the greater part of the pterygium, or the whole of it, if it be small, is removed.

If the base of the growth be large no attempt should be made to excise the *whole* of it, as the too free removal of the conjunctiva will cause a tight cicatrix, which will greatly impair the outward movements of the eye. After the pterygium has been removed, the cut edges of the conjunctiva should be drawn together with one or two fine sutures if the gap is not too wide.

2. Transplantation of the Pterygium.—This operation was first suggested and practised by Desmarres. The operation may be performed as follows:—The lids having been separated by the spring speculum, the extremity of the pterygium is to be seized with a pair of forceps close to the cornea, and its union with that structure carefully parted by a few snips with a pair of fine scissors. One cut is then to be made with the scissors through the conjunctiva along the upper, and another along the lower border of the pterygium. At the point of the lower free cut edge of the conjunctiva, to which it is desired to plant the apex of the growth, a small nick is to be made with the scissors, and into this the cone of the pterygium is to be fixed by a single fine thread suture.

The pterygium, now separated completely from the cornea and implanted into the conjunctiva, generally wastes, and becomes so shrunk that it ceases to draw attention to the eye. The great advantage which transplantation offers over excision of the pterygium is, that as there is no removal of a portion of the conjunctiva, there is afterwards no dense cicatrix to cause a drawing in of the eye or to limit its movements outwards.

Knapp* has introduced a modification of Desmarres's operation for large pterygia. Instead of planting the whole growth into the lower fornix he splits the pterygium in half, and, having excised the head, transplants one half into the lower and the other half into the upper fornix. The gap in the conjunctiva is closed by undermining the upper and lower free edges, and forming two flaps by *vertical* incisions upwards and downwards respectively, near the corneal margin, which are then approximated by sutures.

Pseudo-ptyerygium is a term given to the implantation of a conjunctival fold into the cornea, which sometimes occurs in marginal ulceration accompanied by much chemosis of the conjunctiva, as in burns, scalds, or purulent inflammation. A pseudo-ptyerygium is therefore liable to occur at any part of the corneal limbus, and further differs from a true pterygium in showing no tendency to spread beyond the original limits of the scar. The differential diagnosis can be made by attention to the history; by its shape, which is very variable and does not present the smooth curved outline of the head of a true pterygium; and by means of a probe which, at the site of implantation, can be passed freely underneath the conjunctival fold, and demonstrates its method of origin. In a true pterygium there is no such free passage, and the probe will push a process of conjunctiva before it.

Pseudo-ptyerygia are best left alone, or simply divided across.

* 'Arch. f. Ophthalm.,' Bd. xiv, Abth. i, 1868, S. 267.

PIGMENTATION OF THE CONJUNCTIVA.

Small melanotic patches are occasionally seen in the ocular conjunctiva, usually near the inner canthus. They are most common in people of dark colour, and especially, therefore, in Orientals and negroes. They should be at once excised if they exhibit any tendency to increase in size.

Grey discolouration from nitrate of silver (*Argyrosis*) is apt to follow a too liberal use of this salt or its employment in very strong solutions. The discolouration is permanent.

LITHIASIS OF THE CONJUNCTIVA.

Elderly and gouty people are apt to suffer from concretions in the Meibomian ducts, which appear as minute yellowish points in the palpebral conjunctiva, and are frequently accompanied by a good deal of irritation. They should be excised separately by a needle or by the point of a Beer's knife, and the accompanying conjunctivitis treated on the usual lines. As might be expected, these patients also often suffer from Meibomian cysts (*see "Eyelids."*)

TUMOURS OF THE CONJUNCTIVA.

DERMOID TUMOURS generally spring from the margin of the cornea and the adjacent sclerotic. They are usually smooth, light-coloured growths, covered with conjunctiva, and with a few hairs sprouting from their surface. They are congenital in origin, and histologically are found to contain all the elements of skin. They are often classified with the cornea as corneal dermoids.

Treatment.—The only way to get rid of these tumours is by excision. Whilst operating, care must be taken not to dissect deeply into the sclerotic and cornea, even though the origin of the tumour should apparently be below their surfaces. The flat of the knife should be made to follow the corneal curve as closely as possible, and the tumour rather shaved than cut off the cornea. With attention to this point, there is little fear of causing a perforating wound of the cornea. The cut edges of the conjunctiva should afterwards be approximated by a fine suture. Some permanent corneal opacity is left, which however is a great improvement on the disfigurement caused by the tumour.

SUBCONJUNCTIVAL LIPOMA.—This is an ill-defined hyperplasia of the subconjunctival tissue of congenital origin, which occurs at the outer portion of the eye, and appears as a solid, fatty-looking, vertical fold extending outwards from the conjunctiva beyond the cornea to the external canthus.

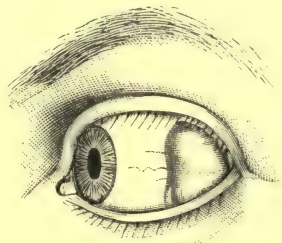


FIG. 77.—Subconjunctival lipoma. The eye is strongly adducted to bring the tumour into prominence.

When the eye is everted the tumour is little noticed, for then it seems to sink back into the fat of the orbit; but if the eye be inverted, the thick whitened fold of conjunctiva at once becomes manifest.

Treatment.—Unless the deformity be very great, it is wise to leave the tumour alone. It usually causes no inconvenience. If an endeavour be made to remove the tumour, it will probably be found to be so intimately connected with the conjunctiva covering it that it will be difficult, if not impossible, to isolate it. The evils which may follow an attempt to remove the growth are a marked unsightly cicatrix and a limitation of the inward movement of the eye.

CYSTS OF THE CONJUNCTIVA are generally simple serous cysts of lymphatic origin. They usually appear as small round or oval translucent bodies, and occasion inconvenience only by their size or their position. Their most frequent site is in the fold of conjunctiva which is reflected from the lower lid on to the globe. They are easily removed by first seizing them with a pair of finely-toothed forceps, and then with a pair of scissors snipping through the portion of conjunctiva which holds them. If an attempt is made to cure one of these cysts by merely puncturing it and letting out the contents, the little bulla is apt to fill up again with blood, and the clear translucent cyst is then converted into a much more noticeable blood-cyst.

Cystycercus cellulosæ is a rare form of cyst forming a movable circumscribed tumour, with thin translucent walls, through which the head of the parasite may sometimes be recognised as a white spot. It is easily removed.

PAPILLOMATA OR WARTS OF THE CONJUNCTIVA usually grow from near the tarsal margins of the lids, but they may spring from other portions of the conjunctiva, especially the caruncle, and even cover a large portion of the globe. They may either be pedunculated or sessile. Sometimes a papilloma will spring from the corneo-scleral margin, and, overlapping the cornea, will simulate an epithelioma. The papilloma however will never infiltrate the cornea as does an epithelioma, and can therefore be raised from the corneal surface with a probe.

The proper **treatment** is excision with cauterisation of the base.

PAPILLIFORM GRANULATIONS.—These are not, strictly speaking, new growths. They are of three kinds, but present similar clinical features:

1. Overgrowths of the conjunctival papillæ after acute or chronic inflammation.

2. Exuberant granulations from an inflamed Meibomian cyst.

3. Vascular protuberant growths, which may attain a large size, sometimes occur in the healing of a tenotomy wound when the edges of the cut conjunctiva have not been accurately adapted.

Each variety forms smooth flat-topped growths, frequently pedunculated, and very vascular. Eyre* has reported two cases of this nature in which the growths were proved to be tubercular.

* 'Trans. Ophth. Soc. U. K.,' vol. xvii, p. 18.

Treatment.—Excision and cauterisation of the base followed by the use of astringent lotions.

LYMPHANGIECTASIS.—Localised dilatations of the conjunctival lymphatics sometimes occur, and usually in the neighbourhood of the palpebral fissure, where they form a collection of minute transparent vesicles, frequently accompanied by an increased vascularity in the surrounding conjunctiva.

The condition requires no treatment and gives rise to no symptoms.

NÆVI of the conjunctiva are usually extensions from nœvi of the lids. Very rarely a nœvus grows primarily in the bulbar conjunctiva. When the nœvus is limited to the conjunctiva, it is best treated by ligaturing its base.

OSTEOMATA.—A few cases of bony tumours growing from the bulbar conjunctiva have been reported. They are probably of a congenital nature and allied to dermoids.

MALIGNANT TUMOURS OF THE CONJUNCTIVA.—These occur as squamous-celled epithelioma (Fig. 78) and sarcoma (Fig. 79). Both forms of growth have a partiality for the sclero-corneal margin, where there is a transition from the pavement epithelium of the conjunctiva to the cylindrical lining of the cornea. Pigmentation is the rule in sarcoma arising in this situation, for which no satisfactory explanation is



FIG. 78.—Epithelioma of the sclero-corneal margin. (From the Museum of the Royal London Ophthalmic Hospital.)



FIG. 79.—Sarcoma of the corneo-scleral margin.

forthcoming; the assertion that has been generally made that the limbus of the cornea normally contains pigment being without foundation.

Epithelioma frequently breaks down, and then forms a spreading ulcer which speedily infects the pre-auricular gland and thence the general lymphatic system. Glandular infection may also be looked for in sarcoma of the melanotic type.

Treatment.—It is rare that any form of treatment other than excision of the eye, as soon as the diagnosis has been confirmed, is justifiable. Certainly, if the sclera is implicated, or there be any glandular infection, it is the only possible one. If the tumour cover a large superficies without deep attachment and no glandular infection, enucleation will still be the only treatment, as the removal of a large

portion of the conjunctival sac would be followed by hopeless cicatricial contraction and deformity. The fact that the eye possesses good vision must not be allowed to impair our judgment with regard to the advisability of its removal.

INJURIES OF THE CONJUNCTIVA.

ECCHYMOSIS.—*Subconjunctival Hæmorrhage* may be caused by a blow on the eye, by coughing, or by any violent exertion, or by fracture of the base of the skull. The effused blood at first appears as a bright red mark abruptly limited to a portion of the conjunctiva, but during the process of absorption the colour loses its intensity, and passes through a variety of shades, which diffuse themselves over the front of the eye.

Treatment.—Except when due to fracture of the skull, a few days' rest is generally all that is required. Cold applications are grateful, and may be used either by allowing the patient to sponge his eyes three or four times a day with cold water, or by prescribing for him some cooling lotion, such as hazeline or boric acid (F. F. 36, 45).

LACERATIONS of the conjunctiva covering the eye, but without any other injury to the eye or eyelids, are generally occasioned either by the patient striking his eye against some sharp projecting object, which catches the conjunctiva and tears it as the head is moved away; or else by some second person running a shutter, or a pole, or whatever he may be carrying against the eye. Scratches from the claws of a cat are also quite common in children. The injury is usually followed by swelling of the lids and conjunctiva, often sufficient to render it difficult to make a thorough examination of the eye a few hours after the accident.

Treatment.—The eye should be closed; some wet dressing should then be laid over the lids and fastened in its place by one turn of a roller bandage. It is very rarely necessary to apply any sutures to keep *in situ* the torn edges of the conjunctiva, as they usually fall together of their own accord; and there is seldom afterwards any sufficient strain to draw them apart or to prevent union. An exceptional case might occur in which sutures would be called for: thus, if a flap of the conjunctiva was torn from the globe, so that it was reflected back on itself, one or two fine stitches would be required to hold it after it had been restored to its proper position. When all the swelling of the lids and conjunctiva has completely subsided, if there is some mucopurulent discharge, two or three drops of a lotion of sulphate of zinc (F. 55) may be dropped into the eye twice a day.

For diseases and injuries of the conjunctiva of the eye-lids *see* section "Diseases of Eyelids."

CHAPTER XI.

DISEASES OF THE CORNEA.

ANATOMY.—The cornea covers the anterior $\frac{1}{6}$ of the globe, and is convex, with a more pronounced curve than the sclerotic. It is thinnest at its centre, and thickest at its periphery, where it measures about 1 mm. It is non-vascular, but permeated by lymph channels, which diffuse a nutrient fluid derived chiefly from the network of vessels which surround its margin or limbus, but partly perhaps from the aqueous humour. It is very richly supplied with nerves from the ciliary and conjunctival plexuses, which ramify very extensively in the superficial layers, and penetrate the epithelium, a fact that accounts for the extreme sensibility of the cornea and the severe pain caused by superficial corneal abrasions. The cornea consists of the following layers, enumerated from before backwards :

1. *Several layers of transitional epithelium*, the most superficial stratum consisting of flattened cells continuous with the conjunctival epithelium, whilst the deepest strata are cylindrical.

2. *Bowman's membrane*, which is a delicate homogeneous membrane interposed between the epithelium and the

3. *Corneal substance proper*, which consists mainly of bundles of fine connective tissue arranged in well-defined lamellæ, and closely united to each other by interlacing branches. Between these bundles is contained the abundant system of lymph-channels above-mentioned, and a series of specialised, large, flattened, nucleated cells known as *corneal corpuscles*.

4. *Descemet's membrane* lines the corneal substance posteriorly. It is a well-defined homogeneous structure, both elastic and tough, and offers great resistance in cases of destructive ulceration of the cornea.

5. *A layer of flattened cells* continuous with the epithelium covering the iris.

For the method of insertion of the cornea into the sclerotic see "Sclerotic."

For the anatomy of the angle of the anterior chamber see "Iris."

CONGENITAL ABNORMALITIES.

A central opacity of the cornea is not uncommon as a result of foetal inflammation, and is frequently associated with the presence of an anterior polar cataract. Buphthalmic eyes often exhibit maculae dotted irregularly over the cornea, and in microphthalmos the cornea may be entirely opaque. A rare congenital anomaly consists in a white ring surrounding the cornea close to the periphery which bears a strong

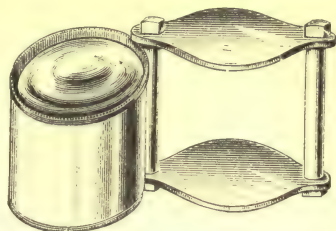


FIG. 80.—Powerful pocket lens for examining fine details, with oblique illumination.

likeness to an arcus senilis, and so has received the name of *arcus juvenilis* (Wilde) or *Embryotoxon* (Fuchs).

KERATITIS—*Inflammation of the Cornea.*

Strictly speaking, the cornea being avascular cannot become inflamed; but the term is convenient and general, and is intended to denote the phenomena that take place under certain pathological conditions, which we associate with the term inflammation, in vascular structures.

Keratitis is best described by dividing it into two main varieties—

1. **Keratitis occurring without ulceration** (Non-ulcerative keratitis).
2. **Keratitis accompanied by ulceration** (Ulcerative keratitis).

NON-ULCERATIVE KERATITIS.

INTERSTITIAL KERATITIS.—A chronic vascular infiltration of the cornea commonly affecting both eyes in succession, and characterised by the rarity with which it is followed by suppuration, and by its tendency to ultimate recovery.

Symptoms.—The disease is one of youth and adolescence, occurring rarely after twenty-five years of age and not usually before the age of eight years. It commences as a diffuse haziness, generally at some spot at the periphery of the cornea, accompanied by ciliary injection, and into which blood-vessels may be seen creeping from the limbus. The vascularity of the patch is sometimes so excessive that the term "*Salmon patch*" has been applied to it. The interstitial deposits increase in number and size and coalesce the one with the other, and thus the infiltration spreads round the circumference of the cornea and

advances at the same time towards its centre until the whole cornea appears opaque. At this stage vision is practically abolished; the cornea has lost its brilliancy and has assumed a characteristic dull ground-glass appearance, the cloudiness of which is seldom uniform, but marked by patches of deeper density than the rest. Thus in the most severe cases the central area of the cornea is often differentiated by a yellowish ring of peculiarly opaque tissue, whilst in the mildest attacks the disease may be arrested before the cornea is completely opaque, or be limited to certain portions of the cornea. The degree of vascularisation also varies considerably, and as a rule does so directly with the intensity of the infiltration. Accompanying the corneal changes there are always indications of a concurrent irido-cyclitis manifested by ciliary injection, a marked increase in the depth of the anterior chamber from hypersecretion, and often by the formation of posterior synechiæ. Subjectively there is some intolerance of light, though not usually severe,

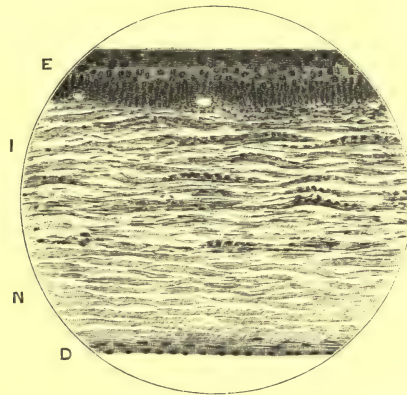


FIG. 81.—Microscopical section of a cornea affected with interstitial keratitis. •

(E) Epithelium lined posteriorly by Bowman's membrane, beneath which some new blood-vessels are seen. (I) Infiltrated portion of corneal substance. (N) Normal cornea. (D) Descemet's membrane.

and not infrequently some supra-orbital pain. Ulceration of the cornea is very rare even in the worst cases. We have only seen two cases of the kind, both of them affected with congenital syphilis, and in both the ulceration was central, and went on to perforation and complete loss of sight. Both were cases of the class mentioned above, in which the centre of the cornea was the part most densely infiltrated.

Pathology and Ætiology.—The disease consists of a small-celled infiltration and œdema of the substantia propria of the cornea which also involves the uveal tract to a variable extent. The ciliary body is always affected, and by some is regarded as the primary focus of the disease, but participation of the choroid is irregular, and when present is more commonly limited to its anterior portions. Occasionally a general disseminated choroiditis occurs, but the disease as a rule has a much greater tendency to pass forwards to the cornea than backwards along the choroid. The ingrowth of new vessels is an integral part of the

disease and not merely a process of repair, and it therefore occurs in the earliest stages. The vessels follow the line of infiltration, and so are frequently found in the deepest as well as the superficial layers of the

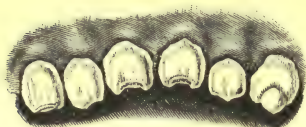


FIG. 82.—Teeth in congenital syphilis. (After Hutchinson.)

cornea, never however being found superficial to Bowman's membrane. In Fig. 81 they are seen to be aggregated just beneath this structure, the infiltration at this spot being most marked in the superficial corneal planes (*see also* "Pannus"). By far the largest number of patients are the subjects of congenital syphilis, and present the characteristic physiognomy described by Hutchinson, "of which a coarse flabby skin, pits and scars on the face and forehead, cicatrices of old fissures at the angles of the mouth, a sunken bridge to the nose, and a set of permanent teeth peculiar for their smallness, bad colour, and the *vertically notched edges of the central upper incisors*, are the most striking characters"* (Fig. 82).

Interstitial keratitis may also occur, though rarely, as a complication of acquired syphilis. In the few recorded cases of this kind the disease has generally occurred as a late secondary manifestation, and has been limited to one eye.

Tuberculous subjects are also liable to a variety of interstitial keratitis which in its main features resembles the syphilitic type; but in the former the infiltration is usually much more patchy and irregular in distribution, and never exhibits the intense vascularity so often seen in syphilitic cases. It is also more relapsing and intractable, and whilst clearing up at one spot is apt to increase at another, and lastly the disease frequently remains confined to one eye. A small minority of cases are still left in which rheumatism seems to have been the predisposing factor in the absence of all evidence of syphilis or tubercle, and we have recently had under our care a case of this nature in which both eyes were affected, and the ocular symptoms accompanied by rheumatic swelling of the joints.

Duration and Progress.—The disease usually reaches its height in from three to six weeks, and then remains stationary for a variable time before resolution commences. The infiltration disappears in the order of its appearance; the peripheral portions of the cornea, as being the nearest to the main blood-channels, regaining their transparency comparatively quickly, whilst the central portion may remain clouded for many weeks or months. The second eye usually becomes affected in from one to three months after the first, and runs through a similar course. The *total* duration of interstitial keratitis is very variable. In very mild attacks the eye may have recovered in a couple of months from the commencement of the attack, but far more commonly the disease lasts from four to six months, and even longer in the most severe types. Relapses are also liable to occur during the recession of the disease, although after recovery is once established a second attack is uncommon.

Prognosis.—Considering the usual density and extent of the corneal

* 'Syphilitic Diseases of the Eye and Ear,' p. 30.

opacity during the height of the disease, the prognosis is remarkably good. In a few cases the restoration of sight is quite perfect; but this can only occur when the infiltration has been superficial or partial, and the disease has run a much milder course than is usually the case. The rule is for the sight to be in great measure regained, and for patches of nebulosity to remain, which impair vision in accordance with their situation and density. In not a few of the severe cases the pupillary area of the cornea remains permanently hazy, and occasionally a dense white central leucoma is left, which may yield and become staphylo-matous under intra-ocular pressure. In all well-marked cases the corneal blood-vessels, though losing their patency, and shrinking, can be recognised years afterwards as white unbranching threads permeating the corneal tissue. They are best seen with the ophthalmoscope, using the direct method and a convex lens of + 20 D.

Treatment.—Locally nothing seems to give so much relief in the acute stages of the disease as hot bathing carried out in the manner described on page 144 with the *Lotio Belladonnæ* (F. 41). Atropine should be used of a sufficient strength to keep the pupil well dilated; it eases the pain by placing the eye at rest, as well as warding off posterior synechiæ. In syphilitic cases the *Ung. Flav. Dil.* may be usefully combined with the atropine (F. 67), and the ointment should then be massaged nightly over the cornea. Bandaging the eyes should be avoided, and dark neutral protectors worn instead. Constitutional treatment is as important as local measures. Opinions differ as to the efficacy of mercury in constitutional syphilis, but we have found much benefit from it, particularly in children, and generally prescribe it in these cases as the *Pil. Hyd. c̄ Creta.* in doses of grs. j to grs. ij twice or thrice daily, according to the age of the patient. In both syphilitic and strumous children cod-liver oil and the syrup of the iodide of iron in small doses do much good. But the greatest benefit will be derived from bracing country or seaside air, strict cleanliness, and a well-regulated nutritious diet, in which pure milk and new-laid eggs form a large part.

The disease is of a particularly depressing nature, owing to its lengthy duration and the great loss of sight, and it is important to combat this by making the patient's surroundings as cheerful as possible. Thus the patient should not be cooped up indoors or kept in a dark room, but should be sent out for daily walks or drives, wearing dark glasses and avoiding keen winds.

DIFFUSE SUPPURATIVE KERATITIS—*Abscess of the Cornea—Onyx.*—This is generally the result of an injury, such as a contused or lacerated wound of the cornea, which has healed over superficially, whilst septic material is left enclosed; but it may also occasionally occur from some constitutional cause without the intervention of a wound. It may follow any operation on the eye in which the cornea is involved, and it is one of the most fatal terminations of the operations for cataract. The state of health of the patient at the time of the injury determines very much the form of the inflammation which may arise from it. A simple incised wound or an abrasion of the cornea, from which a strong

healthy person would probably recover without an untoward symptom in a few days, may be sufficient to induce in an unhealthy patient a diffuse suppurative keratitis which will destroy the eye.

Symptoms.—The cornea grows dull and steamy; pus is effused between its lamellæ, at first only in a small quantity at one spot, but it soon increases and diffuses itself throughout the corneal structure. In severe cases the whole tissue of the cornea may be pervaded with pus, but in the slighter ones it is generally confined to one part.

The eye is hot and painful; there is great congestion of the conjunctival and sclerotic vessels, dread of light, and lacrymation. The deeper parts of the eye participate in the inflammation, the iris loses its mobility, the aqueous becomes serous, and pus is effused into the anterior chamber (*hypopyon*).

The pus between the layers of the cornea now makes an exit for itself, and this it does by progressive ulceration either anteriorly towards the surface, or posteriorly into the anterior chamber. In the majority of cases the corneal abscess bursts anteriorly, and a sloughing ulcer is left.

Results of Suppurative Keratitis.—If the whole cornea has been involved in a diffuse suppurative inflammation, and pus has been effused throughout the whole or greater part of the corneal tissue, complete loss of the eye must follow. If, however, the abscess of the cornea has been limited in extent, the eye may recover, but a leucoma will remain, which will impair the sight in proportion to its size, density, and position with respect to the pupil.

Treatment.—Warm fomentations of belladonna or of poppy heads (F. F. 7, 8) to the eye; and in the intervals between using the fomentations, a fold of linen, wet with the belladonna lotion (F. 41), may be laid over the closed lids. Atropine in the form of drops or ointment (F. F. 10, 57) should be used two or three times daily. But as soon as it is evident that the process is spreading, or the tension runs up, or hypopyon forms, the only line of treatment likely to be of service is a Sämisch's section of the infiltrated part, as described on page 147. Paracentesis of the cornea (page 147) acts in the same way, but its effects are not so permanent or beneficial. The wound caused by the Sämisch section may be kept open for a few days, until healing is firmly established.

Constitutional Treatment.—The patient should be supported with a liberal diet and a fair allowance of stimulants. Tonics and diffusible stimulants are the most suitable medicines, and pain and restlessness should be checked by opiates. Attention should be paid to the regular and healthy action of the bowels, and it is as well to commence treatment with a brisk purge.

FILAMENTARY KERATITIS.—This is a rare and very curious affection, the cause of which we know nothing, and which consists in the formation of excrescences from the epithelium of the cornea, which may attain considerable size (2 to 3 mm.) and then droop down over the cornea as slender transparent threads, giving rise to marked symptoms of irritation. The researches of Nuel, Leber, Czermak, Hess, and Uhthoff have shown that each filament consists of epithelial cells, elongated and

flattened into fibrils, which by process of growth and by the rubbing of the cornea against the lids have become twisted on each other cable-wise, so as to form a spiral coil or pedicle, terminating at its free end in a globular or club-shaped head. The epithelial nerve terminals share in the process, and each filament thus contains an elongated nerve-fibril, which renders it very sensitive, and not only gives rise to general symptoms of photophobia and lacrymation, but is the cause of definite pain, whenever by the movement of the lids or other cause any traction is exerted on the filaments themselves. The disease is both chronic and relapsing, the filaments generally appearing in eruptions, which may last some weeks and then disappear, whilst fresh outbursts may take place at varying intervals and indefinitely prolong the case over many months or even years.

Treatment.—No satisfactory method of permanently eliminating the disease has yet been discovered; and at present our endeavours are limited to relieving the distressing symptoms of the eruptions by removing the filaments under cocaine, a procedure that gives instant relief, but is attended by no lasting benefit. Nuel speaks favourably of a 2 per cent. aqueous solution of ammonium chloride, which he has found to diminish the eruptions by favouring exfoliation of the epithelium. During the attack a light pressure bandage is of service in keeping the eye at rest.

SUPERFICIAL PUNCTATE KERATITIS is a term given by Fuchs, who was the first to describe the affection, to a chronic form of keratitis, frequently bilateral, most commonly seen in young subjects, and characterised by the presence of grey punctate infiltrations situated quite superficially and showing no tendency to break down. Fuchs considers the affection to be closely allied to febrile herpes of the cornea in that it generally appears under similar conditions; but there is no vesicular formation, although the epithelium may be here and there slightly raised by the underlying exudate. There is a good deal of pain and photophobia, and generally an accompanying conjunctival catarrh, the obviousness of which may cause the surgeon to overlook the corneal trouble, especially as the infiltrations may be so minute as to need a careful examination to perceive them, and a slight cloudiness of the corneal surface may alone attract the attention. The spots tend to slowly disappear in the course of several weeks, and a good, though tardy, recovery is the rule. Nuel, who has investigated the pathology of this disease, has found that the infiltrations consist of collections of felted fibrin which lie under Bowman's membrane, and are probably the product of bacteria, colonies of which are to be found in the immediate neighbourhood.

Treatment.—This consists in rest and protection for the eyes by dark glasses and atropine, whilst mild astringent lotions may be used to overcome any conjunctival inflammation.

DEEP PUNCTATE KERATITIS—*Keratitis punctata*.—This is not a true corneal affection, but occurs merely as a *symptom* of an irido-cyclitis. It will be therefore found described in the chapter on "Diseases of the Iris and Ciliary Body" (see page 206).

SCLEROSING KERATITIS is a name given to the deep-seated opacities that result from secondary infiltration of the cornea in deep inflammation of the sclerotic (see "Scleritis"; also "Cyclites," page 209).

STRIATE OPACITY, or as it is sometimes called, **STRIPED KERATITIS**, is a grey infiltration which upon careful observation is seen to be made up of a series of closely set and delicate lines or stripes. It occurs as an occasional complication of corneal wounds, and the majority of cases have arisen in connection with cataract extraction, especially when strong antiseptic lotions, particularly those of mercury, have been employed during the operation. The striate opacity has been demonstrated by Nuel* to be caused by a wrinkling of Descemet's membrane, which is thrown into a series of linear folds mostly running at right angles to the direction of the corneal wound, the wrinkling being accompanied by some œdema of the deeper corneal layers. Nuel's observations have been since confirmed by other writers (Hess, Schirmer, etc.). Striate opacity causes no subjective symptoms, and its presence does not herald any danger to the eye; nor does it cause more than a temporary impairment of vision, for the cornea gradually once more regains its transparency, though in severe cases it may take several weeks to do so. It may further be noted that a similar wrinkling of Descemet's membrane has been observed as a result of marked lowering of the intra-ocular tension in some cases of detachment of the retina and shrinkage of the globe.

ULCERATIVE KERATITIS.

GENERAL OUTLINES—Ætiology and Pathology.—Corneal ulcers are either primary, or secondary to a pre-existing inflammation of the conjunctiva. The causation of primary corneal ulcers, if we except injury, is often obscure, but in such cases the patient is always in poor general health. Most commonly he suffers from general debility, is pale and generally out of sorts, and frequently of a pronounced strumous type; on the other hand, corneal ulcers are not uncommon in an exactly opposite class of cases, viz. in plethoric gouty patients and those suffering from the effects of chronic alcoholism. The decrease in vitality that accompanies advancing years is also responsible for the large number of patients who are over middle age; and some forms of corneal ulceration are almost confined to elderly people. In a certain number of cases trauma is the cause, and the ulcer follows an abrasion, or a burn from acid, sparks, or lime, or the inflammation spreads from the lodgment of a foreign body on the cornea. In other cases, again, a non-ulcerative inflammation of the cornea may break down, as sometimes happens in very acute forms of interstitial keratitis, and is always the case in the vesicles of Herpes zoster corneæ. So, too, when pus is confined within the corneal lamellæ, as in the condition known as corneal abscess, it may rupture through the corneal planes to the surface; and lastly, in a few instances, the ulcer is the result of a local tropho-neurosis, a degenerative rather than an inflammatory process, and of this type are the ulcerations that are apt to occur in old lost eyes. The presence

* 'Congrès de la Soc. Franc. d'Ophth.,' 1892.

of specific bacteria has now been proved in many forms of corneal ulceration. In *secondary* ulceration following gonorrhœal, diphtheritic, or acute catarrhal conjunctivitis the specific bacterial origin has long been demonstrated; but in some forms of *primary* ulceration as well, the process seems to be due to a specific germ. Thus, for instance, the researches of Uhthoff, Axenfeld, and others have demonstrated the almost constant presence of the *pneumococcus* of *Fraenkel* in serpiginous ulcer (*Ulcus serpens*); and in other forms of suppurative keratitis, pyogenic bacteria, such as the *Streptococcus*, the *Staphylococcus pyogenes aureus*, etc., have been found in pure culture.

Symptoms and Progress.—Subjective symptoms are very variable. The exposure of corneal nerve-endings is always accompanied by some pain except in cases when the ulceration is due to a tropho-neurosis and the cornea is in consequence partly or wholly anæsthetic. Generally speaking, pain is most marked in large superficial and acutely infiltrating ulcers; and in the latter class especially, the pain is very severe on account of the pressure of inflammatory exudations upon the nerve-fibrils; whilst in ulcers characterised by very rapid necrosis, such as those which follow gonorrhœal or diphtheritic conjunctivitis, pain is more or less annulled by the rapid destruction of the nerves themselves. Photophobia and lacrymation are always present, but like the pain, vary very much and are generally proportionate to the severity of the latter. With photophobia there is always a certain amount of blepharospasm or convulsive action of the orbicularis, and in children these symptoms are also associated with spasm of the ciliary muscle, which comes on with the slightest admission of light to the eye, and which, by the pain it causes, largely increases the severity of the photophobia and blepharospasm and materially adds to the difficulty of treatment (*see also* "*Phlyctenular Ophthalmia*"). Inspection of the eye will reveal some ciliary injection often limited to the region nearest the ulcer, but general and intense if iritis is associated with the corneal mischief. The ulcer itself is generally manifested by the presence of a depressed patch where the cornea looks rough and grey, and has lost the mirror-like reflection that always proceeds from healthy corneal epithelium; or in the case of sloughing ulcers by a sodden-looking and yellow necrotic area. In the immediate neighbourhood of the ulcer the cornea is hazy from small-celled infiltration and swelling of the corneal lamellæ, and in severe cases this haze may spread throughout the whole of the cornea so as to give it the appearance of having been steeped in milk and water. Corneal ulcers run very variable courses. Some yield readily to treatment and are easily limited to the superficial planes, whilst others again are most intractable and tend to perforate the cornea and destroy the eye in spite of every care.

Let us first take the case of an ulcer the progress of which has been arrested. Healing is accompanied by a temporary increase of opacity in the region of the ulcer itself, whilst the surrounding infiltrate becomes absorbed and the cornea elsewhere regains its normal transparency. This increase in opacity is due to the floor of the ulcer becoming coated with the granulating material that ultimately forms the cicatrix. If the ulcer has invaded the substantia propria, the loss can only be

replaced by fibrous tissue which is opaque, and a permanent haze will therefore always mark the site of the ulcer. If the superficial planes of the cornea have alone been invaded the resultant cicatrix will not be sufficiently dense to exclude light although marring vision, and such a translucent scar is known as a *nebula*. When, on the other hand, the ulcer has extended very deeply the fibrous-tissue formation may be too dense to allow of the transmission of light, and the opacity is then known as a *leucoma*. The density of the scar when freshly healed is however no criterion of the ultimate result, as considerable absorption may subsequently take place, and in children especially this is so marked that a perfectly opaque cicatrix may in the course of some months have cleared up so as to be barely distinguishable.

The healing of some ulcers is marked by vascularisation of the affected zone by the creeping in of new blood-vessels from the corneal limbus. These vessels are offshoots from the episcleral vessels and pass beneath the corneal epithelium sometimes in such numbers as to form a vivid red band or leash which bridges the space between the ulcer and the margin of the cornea. The process of repair being completed they shrink and become avascular, but never absolutely disappear, and in some cases they still retain their patency, so that they may again become active blood-channels should a recurrence of inflammation occur (*see also* "Pannus").

In the second place let us consider the conditions that follow a spreading ulcer. A corneal ulcer generally spreads both by increase of superficies and by progressively deepening infiltration; but sometimes, as in ulceration from neuropathic cause, there is little or no tendency to infection of the deeper planes, whilst the whole superficial area of the cornea is destroyed; and, on the other hand, some ulcers, such as the marginal ulcer and the *ulcus serpens*, are characterised by their deep rodent action.

The involvement of the deeper corneal layer or the advent of secondary iritis is often heralded by an exudation of leucocytes derived from the engorged anterior ciliary vessels, which is poured out into the anterior chamber and gravitating to the bottom forms a yellow collection of lymph known as "*hypopyon*" (*υπο*, below; *πυον*, pus). This term remains in general use though it is now recognised that the lymph, in the first instance at any rate, is completely sterile and therefore not strictly pus. The importance of *hypopyon* lies in the fact that it marks a very acute phase in ulceration, and is a signal for prompt and energetic remedial measures.

If the progress of the ulcer be still unarrested, the cornea will be perforated and complete destruction of the eye is very likely to follow; but this misfortune is often delayed by the resistance offered by Descemet's membrane, which may, in such cases, be seen bulged forwards by the pressure behind, and protruded from the floor of the ulcer like a transparent bleb or vesicle. Such a protrusion is known as a *keratocele*. At this stage too the intra-ocular tension is often increased by serous exudation into the anterior chamber, whilst inflammatory adhesions may bind the pupil to the capsule of the lens (*posterior synechiæ*) at various points. Actual perforation may be the signal for a general

infection and suppuration of the *globe* (*Panophthalmitis*); or if the perforation be very large, the contents of the eyeball may be extruded. In less malignant cases the relief of tension afforded by the escape of aqueous, acts beneficially on the ulcer, the progress of which becomes arrested, though the healing is often accompanied by phenomena which ultimately bring about the complete destruction of the eye as a visual organ.

With the rush of aqueous that immediately follows perforation the iris is prolapsed into the wound unless the aperture be centrally situated and very small, in which case the application of the lens may prevent the iris from prolapsing. In the most favourable cases the ulcer ceases to progress; the wound is soon plugged by adhesions between the prolapsed iris and the lips of the ulcer, the anterior chamber is re-formed, and healing takes place with the iris entangled in the cicatrix (*anterior synechia* or *leucoma adherens*). In others, however, the anterior chamber never becomes re-formed, the ulcer still progresses, more and more iris is prolapsed, partly from increase in the size of the perforation, partly from the drag exerted by that already protruded, until the greater part of the iris is thus extruded; or, again, the iris and lens, at first only applied to the back of the cornea by the evacuation of the aqueous, may

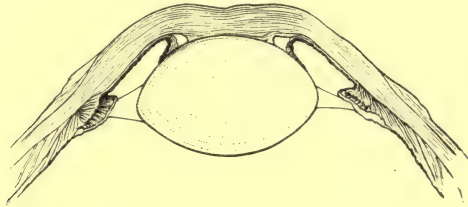


FIG. 83.—Total anterior synechia, pseudo-cornea, and secondary glaucoma. (After Priestley Smith.)

The iris is adherent to cornea, the anterior chamber is not re-formed, the angle of the anterior chamber is obliterated, and the lens capsule is incorporated in the cicatrix.

become firmly fixed by inflammatory adhesions in their new situation (*total anterior synechia*). Thirdly, the anterior chamber may fail to close owing to the establishment of a permanent leakage or fistula (see "Corneal Fistula"). After a perforation the repairing granulation tissue is in great measure derived from the intercepting iris, and the cicatrix, which consists of opaque fibrous tissue covered posteriorly by atrophied iris and uveal pigment is termed a "*pseudo-cornea*." If the anterior chamber remains obliterated, secondary glaucoma will soon be set up by the obliteration of the angle of the anterior chamber (see also "Secondary Glaucoma"), and will complete the destruction of the eye, whilst in the face of the heightened intra-ocular tension the pseudo-cornea gradually yields and becomes staphylomatous (see "Corneal Staphyloma"). If the anterior chamber be re-formed, secondary glaucoma will probably be averted; but a large pseudo-cornea remains a source of danger to the further safety of the eye, not only because it may exhibit a tendency to give way and bulge, but also on account of the liability of the entangled iris to become inflamed and to prove a ready means of conveying infection to the deeper structures of the eye. Lastly, the impairment of vision due to a leucoma will be increased by displacement

of the pupil from prolapse of the iris towards the site of perforation, and in some cases by the formation of an anterior polar cataract marking the spot where the lens has come into temporary contact with the cornea.

Diagnosis.—This is frequently obvious, but by no means always so. The roughness and loss of surface, the absence of polish which comes from healthy corneal epithelium, with the clinical signs of photophobia, ciliary injection, and perhaps hypopyon, may make the diagnosis easy enough; but in some cases there may be difficulty in distinguishing an ulcer from an infiltration or a nebula. In an infiltration the signs of corneal inflammation already mentioned are present, but no loss of surface is visible, and it is therefore only liable to be mistaken for an ulcer in a case where the latter is of a rodent or undermining nature and its edge masked by overhanging tissue. From a nebula the diagnosis can be made by observing the polished glassy surface of the latter and the absence of signs of corneal irritation, though in some cases confusion arises when the nebula is recent and some photophobia is still present, or when it is depressed or faceted and the epithelial reflection is difficult to make out. Superficial and transparent ulcers may be passed over by a too casual inspection, and in many cases the difficulty in diagnosis is vastly increased by the presence of severe photophobia and blepharospasm. In all doubtful cases however a correct diagnosis may be made by allowing a drop of fluorescein to flow over the cornea, upon which any ulcerated area is immediately stained a bright emerald green, whilst surface protected by epithelium is unaffected.

The Treatment of Corneal Ulcers.—*This is General and Local.*

General Treatment.—In primary ulcers, the result of overwork or debility, the patient should be supported with a liberal diet and a fair allowance of wine or beer. Diffusible stimulants and tonics are the most suitable medicines; and if there is much pain or inability to sleep opiates should be given, either in small doses during the day, or in one full dose at bedtime. Attention should be paid to the regular and healthy action of the bowels, and, if necessary, some mild purgative or alterative be prescribed. In ulceration secondary to purulent conjunctivitis a similar line of treatment should generally be adopted; but when the patient is plethoric, gouty, or alcoholic, depletory measures are indicated, and treatment should be commenced with a brisk purge, followed by the daily administration of small doses of mercury, which is often combined advantageously with a morning draught of some natural aperient water, such as Hunyadi Janos or Apenta. In such patients, too, the diet should be light, and stimulants reduced or stopped altogether; and if the patient is alcoholic, the addition of a little of the Tinct. Capsici. combined with the carbonate of ammonia will often be of service when stimulants are being cut off.

Local Treatment.—When the ulceration is secondary to infection from the conjunctiva, the first attention must be paid to improving the condition of the conjunctival sac, and the remedies already described in the treatment of "Catarrhal," "Gonorrhœal," or "Diphtheritic Conjunctivitis" at once applied in addition to those given below.

a. Primary Measures.—*Fomentations* are of the greatest service. The eye should be washed out frequently with some warm lotion, and in the

intervals a moist compress should be kept applied, and changed from time to time as it becomes dry. Frequent irrigation is especially called for in the case of sloughing ulcers, when an antiseptic should be used, the Lot. Quin. Sulph. (F. 50) or Lot. Hydrarg. Perchlor. (F. 46) being especially useful, though in other cases a more soothing lotion, such as the Lot. Ac. Bor. (F. 36), or the Decoc. Papaveris (F. 8), or even plain hot boiled water are quite efficient and are more grateful to the patient.

Bandage.—By keeping the eye closed with a bandage the natural winking of the eye, which is much increased by the pain and photophobia, is arrested. The movement of the upper lid, by rubbing against and irritating the ulcerated surface, increases the pain and photophobia, and in this way keeps up a vicious circle, which is arrested by a light bandage. It must, however, only be used with extreme caution in *secondary* ulceration of the cornea for fear of penning up the discharges between the lids, and, as a rule, it is contra-indicated in these cases, because the swelling and œdema of the lids suffice to keep them closed. In the phlyctenular ulceration of childhood, too, the use of the bandage is also limited (*see* page 159).

Mydriatics and Myotics.—Mydriatics are of the greatest value when iritis is present or when there is much pain and blepharospasm, as in phlyctenular ulcers: in the latter case they act beneficially by relaxing the accommodation, and so placing the eye at rest. In these two classes fairly strong solutions of atropine (grs. ij to grs. iv ad ʒj) should be employed, but in other cases, when there is no iritis, and subjective symptoms are not marked, the routine use of strong solutions of atropine as advocated by many surgeons is, in our opinion, to be deprecated, as the drug has no direct influence upon the course of an ulcer, and in strong doses is apt to delay healing by promoting a tiresome conjunctival irritation. In these cases one drop of weak atropine (grs. j ad ʒj) placed once or twice a day between the lids will act as efficiently in relieving symptoms as a stronger solution. When ulceration, too, is accompanied by increased intra-ocular tension, as is not infrequently the case, especially when the ulcer is deep, atropine should be discontinued or used with extreme caution. In such cases the use of eserine has been frequently advocated in the place of atropine, but with the exception of a small class of cases (*see* page 152), any relief that eserine affords is more than counterbalanced by the danger of increasing or setting up iritis, and it is generally far better to deal with the increased tension by one of the operative measures mentioned below.

Ointments.—In all forms of ulceration the application of a little simple ointment, such as the Ung. Ac. Boric. (F. 56) is comforting to the patient, promotes healing, and relieves the sensations of heat, dryness, and itching. A little may be put on a brush and placed within the lower conjunctival sac by gently drawing the lid down whilst the patient looks upwards, and then directing him to close the lids on the brush which is slowly withdrawn cleared of the ointment by the pressure of the lids upon it. In sloughing ulcers the Ung. Iodoformi (F. 68) is useful, but should be used in small quantities so that it does not lie on the skin which it is apt to irritate. When an ulcer has begun

to heal stimulating ointments such as the Ung. Flav. Dilut. (F. 66) are often of great service, and their effect is increased if the ointment is gently massaged over the cornea by means of the finger through the closed lids.

b. Secondary Measures.—These are only to be adopted if, under the above lines of treatment, the ulcer continues to progress in area or depth; or, if in the first instance experience has taught us, from the characteristics exhibited by the ulcer, that more active measures than those already detailed are needed. These secondary measures are of three kinds:—(1) *Local Applications*; (2) *The Electro-cautery*; (3) *Operative Measures*.

1. *Local Applications.*—These consist in painting the ulcer with highly stimulating or caustic applications, after having first rendered the cornea anæsthetic by cocaine. The drugs most commonly used for the purpose are nitrate of silver in solution or as the mitigated stick, pure carbolic acid, or absolute alcohol. All are valuable methods; but perhaps nitrate of silver and carbolic acid are the most useful and reliable. When only a very limited action is required, it is best to employ the nitrate of silver, using it in solution of grs. v to grs. x ad ʒj, and repeating the painting every other day, or oftener, as may seem necessary; but in highly virulent cases a drop of pure carbolic acid, applied with a glass brush, or the solid silver stick, produces a greater and more lasting effect. With alcohol the best effect is produced by lightly scrubbing the ulcer with a piece of absorbent wool dipped in the drug and held by forceps.

2. *The Electro-cautery.*—This is the most powerful agent we possess for arresting acute infective ulceration. It is especially useful in those cases in which the advance of the ulcer takes place by an undermining process, and the infective edge is consequently not easily reached by other methods, as in the marginal or ditch ulcer and the *ulcus serpens*. On account of the amount of necrosis it causes, the cautery should be entirely reserved for this type of cases, where less severe measures would fail or have proved unsuccessful, and it should always be employed with the greatest discretion, so that no

undue destruction is produced by which the resultant scar will be unnecessarily increased in size or density. The exact limitations of the ulcer should first be defined by staining it with fluorescine; after which the cautery raised to the *dullest* red heat should be lightly drawn around its boundaries, thus marking out the ulcer by a necrotic ring. The infective bacteria are always congregated at one particular edge, by the extension of which the ulcer advances, and it is to this spot that attention



FIG. 84.—Lang's galvano-cautery, with detachable points.

should be paid in particular, and the charring made more deeply than elsewhere. It is not necessary to char the *floor* of the ulcer, for by the above method the ulcer is limited and its progress arrested; and the base can always be satisfactorily dealt with by less severe means without increasing the risk of perforation by destroying fresh lamellæ of corneal tissue, and so lessening the already diminished resistance of the cornea.

3. *Operative Measures.*—When hypopyon supervenes or Descemet's membrane protrudes, or the intra-ocular tension is much raised, the best method of treatment is to evacuate the contents of the anterior chamber. An exception may be made in cases of hypopyon when the condition is present at the time that the patient *first* comes under observation, and we have seen many instances, especially in children, in which the hypopyon has been rapidly absorbed with energetic treatment on the lines already mentioned.

The anterior chamber may be emptied either by (a) paracentesis through the floor of the ulcer, or by (b) a Sämisch's section of the ulcer, or by (c) paracentesis performed in some healthy portion of the cornea removed from the ulcer. The evacuation of the aqueous acts beneficially by reducing intra-ocular tension and thereby annulling pain (although the actual operation is followed by acute pain for a short time, on account of the sudden release of pressure from the congested iris and ciliary body) and by placing the eye in a state of rest conducive to repair. The same results would follow if the cornea were allowed to perforate of itself, but a ragged uneven gap would then be left through which an extensive prolapse of the iris might take place with the formation of a weak bulging cicatrix. The choice of methods depends on the individual case. In ulcers more or less centrally placed we shall best avoid the interposition of the iris by opening through the floor of the ulcer. The evacuation of the hypopyon which is often difficult owing to the tenacious and stringy nature of the lymph is after all a secondary consideration, as it will speedily be absorbed as soon as healing has commenced.

Paracentesis of the cornea, either through the floor of the ulcer or elsewhere, may be performed as follows:—A broad lance-shaped needle (Fig. 107) is made to perforate the cornea at the desired site, the point being kept well forwards towards the dome of the cornea so as to avoid wounding the lens. The aqueous is then allowed to run off slowly, and if hypopyon is present, evacuation of it is attempted by depressing the lower lip of the wound with a curette. The rapid emptying of the chamber always causes much pain, and is not unattended by risks of intra-ocular hæmorrhage. The little operation may be repeated frequently until repair has commenced.

Sämisch's operation consists in making an incision with a fine Graefe's knife through the centre of the ulcer, or the spot which is infiltrated with pus. It should be sufficiently deep to open the anterior chamber throughout the length of the incision, and long enough to include a minute portion of healthy cornea on each side of the ulcer. The lids should be then closed with a compress and bandage, and a solution of atropine dropped twice daily into the eye. In the after-treatment the

eye should be examined daily, and the incision kept open either by gently passing a fine probe or the point of a Graefe's knife between its edges, or by pressing the upper or lower eyelid upon one of the margins of the wound so as to cause it to gape. This treatment should be continued until healthy reparative action commences.

Treatment of Prolapse of the Iris and Anterior Synechiæ.—If the prolapse is seen when it has recently occurred, the entangled portion of the iris should be freed from its adhesions to the wound, and then drawn out as far as possible and snipped off close to the corneal opening. The cut pillars of the iris should then be gently smoothed back from the wound and firm pressure applied with a bandage. By this means, and aided by the instillation of atropine after the anterior chamber has re-formed, we may hope to get a flat cicatrix without the inclusion of any iris. When, however, the prolapse is of long standing, it is hopeless to try and free it in this manner, and we must rely on continued pressure and atropine to get a firm union. If, in spite of this treatment, the scar begins to bulge, we must be guided as to further procedure by the lines laid down in "*Staphyloma of the Cornea.*"



FIG. 85.—Lang's twin knives for the division of anterior synechiæ.

It often happens that, without actually prolapsing, a small anterior synechia is formed during the process of healing, which causes a good deal of disfigurement by dragging on and displacing the pupil. When healing has been firmly completed the iris may in such a case be freed by opening the anterior chamber from the opposite side and cutting through the band with a sweep of a small tenotomy knife. The best instruments for the purpose are Lang's twin knives (Fig. 85). The sharp-pointed knife is employed to make the corneal section and is then laid aside for the probe-pointed one with which there is no risk of wounding the lens or perforating the cornea over the band, and with this the adhesion is divided.

Large and broad anterior synechiæ are not amenable to this treatment and are best left alone.

Should glaucomatous symptoms supervene or the cornea begin to yield, an iridectomy should be performed at some other spot (see "*Staphyloma of the Cornea*").

We now pass to the consideration of **Special Varieties of Ulcerative Keratitis.**

SLOUGHING ULCER OF THE CORNEA may be the result of a diffuse suppurative keratitis, induced either by injury or disease; the pus between the lamellæ of the cornea having worked its way to the surface by progressive ulceration. They are of especial frequency amongst the half-starved and overworked, as well as the drunken and dissipated, and may often be regarded as evidences of failing nutrition and want

of nervous power. They may also result from a simple wound or abrasion of the cornea, either by direct infection from dirt, etc., inoculated in the infliction of the wound, or by subsequent contamination from uncleanness, or an infective condition of the conjunctival sac.

A sloughing ulcer of the cornea usually presents an irregularly excavated surface, with a whitish-yellow sloughy appearance, and with its margins shelving and ill defined. Around the ulcer the cornea is hazy. A well-defined form of sloughing ulcer is known as the **Serpiginous ulcer** (*Ulcus serpens*), so called from its tendency to spread or creep over the cornea. It usually follows an injury or abrasion, and, according to Uhthoff and Axenfeld, is the result of infection by the pneumococcus of Fraenkel, which is *normally* present in the lacrymal ducts, nose, and throat. Serpiginous ulcer is characterised by a sharply marked, yellow, undermined edge, which often presents a crescent-shaped outline, and by which the ulcer advances and creeps over the cornea, leaving behind this margin a depressed greyish area of ulceration to mark its track. It very commonly commences near the centre of the cornea, probably because this is the portion of the cornea most exposed to injury, and it is especially to be dreaded not only on account of the severity of its course, which is marked by the early advent of iritis and hypopyon, but also on account of its intractable nature, and the difficulty of dealing successfully with the infected advancing edge.

Sloughing ulcers often lead to complete destruction of the eye for all visual purposes; but even when they yield to treatment and the eye recovers, it is always more or less a damaged organ. Sometimes they will perforate the cornea, and prolapse of the iris will follow; or occasionally they will penetrate the true corneal tissue, when their further progress will be stopped by the resistance offered by Descemet's membrane. An aperture is then seen in the cornea, the bottom of which is closed by a transparent membrane (Descemet's), which projects slightly into the wound. In this condition the eye may remain for many weeks; the corneal wound may then begin to granulate and heal, but generally the posterior elastic lamina in the end gives way, the iris prolapses, and cicatrisation follows.

Remarks on Treatment.—During the early stages, treatment in most cases should be confined to frequent irrigations and fomentations, combined with leeches and atropine if iritis be present and the case acute and accompanied by much pain; and by these means the progress of the inflammation may be arrested, especially if the case be taken early. If, in spite of these measures, the ulcer progresses, severer measures, such as the electro-cautery or one of the forms of local applications above mentioned, should be employed, and, if the case be definitely one of serpiginous ulcer, it is best to resort fairly early to the cautery as the most effectual method of arrest. If the intra-ocular tension is much raised, paracentesis of the cornea or a Sämisch section of the ulcer is generally followed by much benefit, and sometimes by immediate reparative action, and the same course of treatment should be adopted when perforation is imminent or Descemet's membrane bulges up between the lips of the ulcer.

CRESCENTIC, CHISELLED, OR DITCH ULCER.—This is one of the worst and most intractable forms of ulceration to which the cornea can be subjected, but fortunately it is one of the most rare. The ulcers are called “crescentic” from their shape, and “chiselled” from their peculiar characteristic appearance, as if a portion of the epithelium and true corneal tissue had been cut away with a chisel, or scooped out with the thumb-nail from the margin of the cornea. They always occur at the extreme edge of the cornea, but they are strictly confined to that structure, and do not in the slightest degree enroach upon the sclerotic. In their progress they follow exactly the curve of the corneal margin, by which they are abruptly limited; the circumferential edge of the ulcer being cut sharply and deeply. They spread rapidly and increase both in extent and depth. There may be two or even three of these ulcers at different parts of the corneal margin, and, unless their progress be arrested, they may spread and unite, and

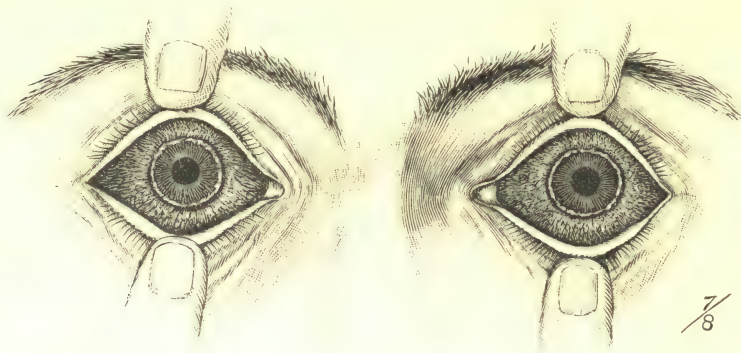


FIG. 86.—Complete marginal ulceration of both corneæ. The patient was an elderly woman broken down in health. She ultimately made an excellent recovery. The intense congestion of the conjunctiva is well shown.

so insulate the central portion (*see* Fig. 86). At the commencement of the disease the ulcers are almost transparent; it is during their healing stage that they grow nebulous. They frequently perforate the cornea, and cause extensive prolapse of the iris; or, as in the sloughing ulcers, the advance of the ulceration may be stopped by the posterior elastic lamina of the cornea; but this usually in the end gives way, and prolapse of the iris ensues. During the reparative process they become first cloudy, then of a greyish-white colour; vessels shoot into them from their sclerotic border, and they are ultimately filled in with a semi-opaque cicatricial tissue.

The crescentic ulcers are usually the source of great pain in the eye and round the orbit, accompanied with photophobia and lacrymation on the slightest exposure to light; but occasionally the reverse is the case, and both subjective and objective symptoms of inflammation are very slight, whilst the corneal sensibility is diminished, as in atrophic ulceration of the cornea (*see* page 151). Iritis is apt to set in early, and in the latter

class of cases it may be of so quiet a nature that it escapes the notice of the surgeon until the pupil is already sealed by posterior synechiæ.

Crescentic ulcers do not seem to be connected in any way with any constitutional taint, such as syphilis or struma. The patients are usually old and debilitated people who are in that state of health which is best described as "being thoroughly out of condition."

Remarks on Treatment.—These ulcers are so intractable, and so many means have been tried without success to check their progress, that it is difficult to say what is the wisest course to pursue. Fomentations with quinine or mercury lotions (F. F. 50, 46) and frequent irrigations should be tried if the case is seen at its commencement; but if they fail to do any good, as is frequently the case, and if the ulcer is well advanced when first coming under observation, there should be but little delay in using more drastic measures, and of these the cautery is, we think, the most reliable. The application may have to be repeated more than once, and the charring must be carried deeply along the curved edge by which the ulcer eats its way into the cornea; but still it must be confessed that some cases will resist even this form of treatment, and in spite of everything will gradually spread round the cornea, cutting off its nutrition, and in the end completely destroy the sight. With local measures a liberal diet and tonics with diffusible stimulants should be ordered, and if there is pain or restlessness opiates should be given either in small doses at short intervals, or in one full dose at bedtime.

THE ATROPHIC ULCER—NEURO-PARALYTIC KERATITIS.—The latter term, by which the following class of cases is most generally known, is unsatisfactory, as it implies the constant presence of an organic paralysis of the ophthalmic nerve, whereas in the large majority of cases the disease is due to functional causes—a tropho-neurosis, or the result of faulty innervation induced by exhaustion and debility. These non-organic cases are confined to elderly people, generally to those broken down in health by advancing years or by disease, and they have been aptly compared by Tweedy* to bedsores, with which they have many points in common. In those comparatively rare cases in which there is organic lesion of the fifth nerve, the corneal affection occurs independently of age and debility, and consists in a "gangrene" of the cornea, the difference being that here nutrition is entirely suppressed, whilst in the former it is only partially arrested.

Atrophic ulceration presents certain well-marked characteristics by which the disease is easily recognised, the most prominent being the paucity of the subjective and objective signs of inflammation in comparison with the apparent severity of the corneal mischief. The patient exhibits but little distress, and presents himself to the surgeon with the eye wide open, complaining that a mist is growing over the sight, or, as we have seen in some cases, merely that the eye pricks and feels uncomfortable. The inter-dependent symptoms of photophobia and lacrymation are slight or completely absent owing to diminished sensibility of the cornea, which in severe organic cases is completely anæsthetic. The degree of anæsthesia is roughly tested by stroking the cornea with

* Heath's 'Dict. of Pract. Surg.,' 1889, vol. i, p. 373.

a thread or a fine twisted piece of wool, a procedure that would be followed by a sudden wince on the part of the patient in health, but in these cases is either not felt at all or only slightly so. In organic cases there is not only absence of lacrymation, but the normal flow of tears is arrested owing to paralysis of the lacrymal gland. By some observers the corneal ulceration has been in such cases ascribed to desiccation following the arrested flow of tears; but this theory is untenable, as the cornea may remain perfectly healthy after removal of the lacrymal gland by operation.

The ulcer most commonly commences near the centre of the cornea, the part most removed from the sources of nutrition, and in the line of the palpebral fissure, where the cornea is exposed to contamination from without. It appears in its early stages as an irregularly shaped greyish depression with ill-defined edges, over which the cornea looks rough whilst still retaining considerable translucency. Beyond this depression, which stains deeply with fluoresceine, there is some slight general haziness of the cornea, but no further sign of inflammation except a slight and usually partial ciliary blush and some pinkiness of the conjunctiva. The intra-ocular tension is sometimes markedly raised, and when this is the case pain, which is otherwise inconsiderable, may become acute.

Atrophic ulcers are most intractable, and their tendency is to progress steadily until the whole surface of the cornea is involved without as a rule showing any inclination to perforate the cornea or cause secondary iritis; this extensive erosion being followed by a tedious convalescence with the formation of a peculiarly dense leucoma. The process of erosion may occupy several weeks, but in some cases the disease runs a fairly rapid course, and in a small minority, which includes those of organic origin, the ulcer sinks deeply into the corneal tissue, and hypopyon and perforation follow.

Treatment.—In organic cases complete destruction of the eye will probably result in spite of every care, and in functional cases, too, the ulcer will in not a few cases resist all treatment, whilst under the most favourable circumstances great patience and perseverance will be needed alike by patient and surgeon in treatment that will extend over several weeks, and perhaps months. Stimulating ointments, caustic applications, and especially the cautery are always strongly contra-indicated, the latter especially tending to further devitalize an already weakened tissue; locally, warm soothing irrigations and compresses are the best remedies, combined with a liberal diet and stimulants as may be deemed advisable. Tweedy strongly recommends the use of quinine both locally, as a lotion (F. 50), and internally, combined with an iron mixture or small doses of calomel in a pill, and we have always found this an excellent treatment. Opium in small doses once or twice daily is also a very useful drug, especially in the tedious convalescent stage. When intra-ocular tension is increased and there is no iritis, considerable relief follows the use of eserine in the form of weak drops (gr. $\frac{1}{2}$ ad $\overline{3j}$); and it is chiefly in this class of corneal ulceration that we have found eserine to possess advantages over atropine (*see also* "Keratomalacia," p. 156). The bandage must be kept rigorously applied for several weeks after the ulcer has healed, and when finally discarded the greatest care must be

exercised in the exposure of the eye, dark glasses being always worn when out of doors.

DENDRITIC ULCER (Grut, Emmert, and others) has received its name from its curious arborescent appearance, which is both distinctive and characteristic. It is a rare form of corneal ulcer, which commences as a superficial grey infiltration that breaks down and then spreads in extending lines that furrow the surface of the cornea in a manner somewhat resembling the branches of a tree or the track of a slug. Its creeping character is very suggestive of a specific micro-organism; but the existence of one has never been satisfactorily determined, and in some cases this form of ulceration has been traced to an attack of febrile herpes of the cornea (Nuel). Its course is marked by considerable symptoms of irritation, and it is very intractable to any but drastic methods of treatment, though fortunately it shows but little tendency to penetrate beyond the superficial corneal planes. •

Treatment.—Local applications of silver nitrate, carbolic acid, etc., or the electro-cautery are the quickest and most efficient means of dealing with a dendritic ulcer. Swanzy* has found scrubbing the ulcer with lint steeped in absolute alcohol a very satisfactory method, and the operation can be repeated once or twice at an interval of a few days if necessary.

MOOREN'S ULCER is a very rare form of corneal ulceration. It is characterised by its slow progress, intractable nature, and great tendency to relapse. It always remains confined to the more superficial layers of the cornea, but may destroy all useful sight by gradually clouding the superficies. It spreads like the serpiginous ulcer by an undermining edge, which generally renders lotions futile and demands energetic treatment by the cautery. The history of some cases may extend over years, relapses occurring at indefinite intervals, and each recurrence causing loss of transparency over a fresh area before its progress can be arrested. It occurs most frequently in middle-aged and old people, and both eyes are liable to be affected.

ULCERS ATTENDED BY THE FORMATION OF VESICLES.

HERPES CORNEÆ FEBRILIS.—The herpetic eruptions that occur about the lips in acute diseases, such as pneumonia, sometimes appear on the cornea. The corneal epithelium is raised in one or more places by minute vesicles which speedily rupture, leaving small superficial grey ulcers accompanied by much photophobia and lacrymation. As a rule they remain quite superficial and tend to quickly disappear as the general health of the patient improves, but sometimes, especially when, as not infrequently happens, there is also a catarrhal condition of the conjunctiva, they may become infected and purulent; whilst in a few cases they have been the starting-point of a dendritic ulcer (*vide supra*). The occurrence of these superficial ulcers in acute febrile conditions has for long been recognised by ophthalmologists, but it is only recently

* Swanzy, 'Diseases of the Eye,' 6th edit., p. 167.

that Professor Horner has pointed out their vesicular origin in connection with herpes labialis.

Treatment.—This should be in accordance with the general lines laid down for the treatment of corneal ulcers (*see* page 144).

HERPES ZOSTER CORNEÆ.—The eye usually escapes in herpes frontalis unless the nasal branch of the ophthalmic is involved, in which case acute iritis is apt to supervene, which is sometimes attended with the formation of herpetic vesicles on the cornea. The ulceration that follows the rupture of these vesicles is especially dangerous on account of the anæsthesia of the cornea and the general lowering of vitality, which is a feature of the disease. Owing to the former, particles of dust, etc., may cling to the cornea and speedily infect the ulcer, whilst the latter favours a rapid spread of any inflammatory process. In this way the eye may be rapidly destroyed by perforation of the cornea, and even in cases which are not attended by so disastrous results the sight is apt to be materially damaged by a dense leucoma.

Treatment.—As a rule stimulating and caustic remedies should be avoided on account of the depression of the tissues and reliance placed on frequent warm and soothing applications, with a pressure bandage and atropine to combat the iritis (*see also* “Herpes Frontalis”).

BULLOUS KERATITIS.—In eyes lost from glaucoma, or in those in which nutrition has been much impaired by long-standing disease of the uveal tract, and especially when the cornea is dotted with deep-seated opacities as a result of such disease, some disturbance, however slight, of the corneal lymph circulation may cause œdema of the cornea, with localised collections of exuded lymph which raise the epithelium into bullæ. The condition may, however, also occur as a primary disease in old and debilitated subjects, though it is exceedingly rare under these circumstances, and further, a similar formation of bullæ may occasionally occur, after injury by a superficial burn or the application of caustic, though the term “bullous keratitis” should not properly be applied to the latter class.

The bullæ, which are accompanied by much photophobia and pain and general steaminess of the cornea, ultimately rupture, leaving behind superficial ulcers which are apt to be obstinate and troublesome on account of the enfeebled vitality of the tissue, whilst for a similar reason a further eruption of bullæ may occur at a future date.

Treatment.—Immediate relief is afforded by pricking the bullæ and so releasing the pressure upon the corneal nerve-terminals. The ulcers should be treated by warmth and soothing applications, avoiding caustics and stimulating remedies on account of the lowered vitality. When the eye is visually lost it may be advisable to excise it in cases of recurrent inflammation, or if the eye remains irritable and the patient's general health begins to suffer therefrom.

KERATITIS E LAGOPHTHALMO.

The term lagophthalmos signifies hare-eyed ($\lambda\alpha\gamma\omega\varsigma$ = a hare) and is a foolish but general term applied to any condition that prevents

closure of the lids, being derived from the old saying that a hare always sleeps with its eyes open. Lagophthalmos may be caused by paralysis of the orbicularis, or mechanically by proptosis of the globe or the protrusion of a corneal or ciliary staphyloma between the lids; but from whatever cause it may arise the condition is accompanied by danger of inflammation and sloughing of the exposed portion of the cornea. As a result of incomplete closure of the lids the act of winking by which the cornea is normally kept lubricated by the tears and free from contamination by dust, etc., is inefficient, and particles of foreign matter are apt to adhere to the exposed portion and set up inflammation, especially during the insensibility of sleep. In normal conditions of health the cornea is protected during sleep not only by closure of the lids but also by an upward rotation of the eyes that occurs immediately on loss of consciousness; and for this reason paralytic lagophthalmos, when the cornea can still shelter under the upper lid, is less likely to be followed by keratitis than lagophthalmos from other causes where there is a mechanical impediment to the upward rotation of the globe.

Lagophthalmic keratitis presents no special features beyond the fact that, as might be supposed, the inflammation is especially apt to involve the pupillary portion or highest part of the corneal curve, and it is consequently attended with much danger to sight.

Treatment.—The old adage that “prevention is better than cure” is very true in lagophthalmic keratitis, and in both paralytic and non-paralytic cases, whilst directing our attention to the relief of the lagophthalmos, the danger of corneal inflammation should be constantly borne in mind, and a bandage ordered to be worn at night and protecting glasses during the day. When ulceration has once started it must be treated on the ordinary lines of other ulcers (*see* “Treatment of Corneal Ulcers,” page 144), and with good prospects of success, though it must sometimes happen that, owing to the impossibility of relieving the primary cause, the patient is in constant danger of a recurrence of inflammation, and in such cases it may be advisable to unite the edges of the lids by a few sutures, so as to reduce the size of the palpebral opening (*see* “Tarsorrhaphy.”) The lids may be thus kept closed for several months if thought necessary.

KERATOMALACIA.

In infants or young children, as a result of extreme debility induced by a long period of chronic starvation or improper feeding, gangrene of the cornea, known as ‘**Keratomalacia**,’ sometimes occurs. It corresponds to the neuropathic ulceration of old people above described, but the constitutional disturbance is far more severe, and from it the child not infrequently dies.

Very frequently both eyes are affected and completely destroyed; but sometimes if suitable constitutional treatment is adopted, the process is arrested with the improvement in the child’s general condition, and recovery follows, though with permanently damaged sight. The disease is essentially a necrosis, not preceded or accompanied by active

inflammation, and therefore not attended by pain, photophobia, or lachrymation. It is sometimes known as *Xerophthalmic keratomalacia*, because many cases exhibit the foamy patches on either side of the cornea, and the night-blindness characteristic of epithelial xerosis (see page 125), itself a disease that only appears in those whose constitution has been lowered by insufficient or improper nourishment.

Keratomalacia is very rare in this country, but Fuchs* points out that it is "fairly frequent in Russia towards the end of the Great Fast, during which the mothers lose their milk, and among the badly nourished children of the negroes in Brazil."

Treatment.—Locally, bandaging, warm fomentations and atropine should be employed, or, if the latter does not seem to benefit, a trial may be made of eserine, which Holmes Spicer† has found very useful in these cases when employed in a solution of gr. $\frac{1}{4}$ to gr. $\frac{1}{2}$ to the ounce. Little benefit, however, must be expected unless the child's general condition improves, and every care must therefore be paid to obtaining a sufficient and suitable diet, pure milk properly diluted for infants, and fresh meat and plenty of green vegetables for older children. If the digestion is not too impaired, cod-liver oil and malt extract are capital foods, and when they cannot be assimilated we have found marked benefit from rubbing the oil into the skin. The disease runs its most severe course in young infants, and in them diarrhoea, vomiting, and other symptoms of marasmus will often cause a fatal termination in spite of all treatment.

PHLYCTENULAR OPHTHALMIA.

This disease consists in the appearance of small nodular swellings on the ocular conjunctiva or cornea. It is therefore as much a conjunctival as a corneal disease; but for the sake of clearness, and as the symptoms evolved are most severe in the corneal affection, the two manifestations are here described together.

Ætiology and Pathology.—The disease is almost entirely limited to childhood and adolescence, and is particularly common amongst delicate lymphatic children who suffer from chronic enlargement of the cervical and other lymphatic glands. It is more frequent among the poor than among the rich; for the impure air of dirty confined lodgings, combined with an insufficiency of sunlight, improper diet, and want of care, will induce the disease in children who, under more favourable conditions, would not suffer from it.

The disease received its name in the wrong belief that the nodules were vesicular in nature (*φλυκταινα* = a bladder), whereas they consist of circumscribed small-celled infiltrations situated just beneath the epithelium, the infiltration being of a mild inflammatory character, and due to some local disturbance in the lymph-paths of the conjunctiva and cornea. The manifestation may be limited to the presence of a single conjunctival or corneal nodule, or may appear as a crop or eruption of irregularly distributed swellings; but in every case there is a great tendency for relapses to occur with the appearance of fresh

* Fuchs, 'Text-book of Ophthalmology,' 2nd edit., p. 176.

† 'Trans. Ophth. Soc. U. K., xiii, p. 45.

phlyctenules whenever the patient gets out of health. The most favourite spots are the limbus of the cornea, where the phlyctenules often invade both the corneal and subconjunctival tissue, and the central or pupillary portion of the cornea, and as a rule they lie in the line of the palpebral fissure or below it, that is in the situations most exposed to the irritating effects of wind, dust, etc. The largest phlyctenules are seen on the bulbar conjunctiva, and here they exhibit but little tendency to break down; whereas the epithelium over the marginal and purely corneal phlyctenules often ruptures, and an ulcer is then formed which may become purulent and perforate the cornea.

On the bulbar conjunctiva the nodules are of a yellowish colour, and are made conspicuous by local congestion of the subconjunctival vessels, which form a red fringe tailing off to the inner or outer canthus, whilst on the cornea the phlyctenule is greyish white owing to the absence of blood-vessels. A peculiarity possessed by marginal phlyctenules is their tendency to creep further over the cornea with each successive relapse, a leash of new vessels from the subconjunctival tissue following in the wake; and in this way the greater part of the corneal surface may ultimately become involved and rendered nebulous from the scars of previous attacks. In many cases, the child being out of health at the time, an attack of catarrhal conjunctivitis will initiate the formation of phlyctenules, and in other cases the eyes become infected from a chronic strumous rhinitis, an exacerbation of which is immediately followed by phlyctenular ophthalmia. Lastly, the disease is also frequently associated with eczema, impetigo, pediculi, and all those kindred complaints so frequently met with among the poor strumous children of a London hospital.

Symptoms.—The severity of the symptoms to which phlyctenules give rise depends upon their situation. When confined entirely to the conjunctiva they cause little disturbance, and often come under the notice of the doctor because of their appearance, which has given alarm to the parents, or notice is attracted from the child complaining of a sense of heat or grittiness in the eye. When the cornea, however, is involved, the symptoms are of a most pronounced and severe character, and for this reason the symptoms produced by marginal phlyctenules vary according to the implication or escape of the cornea, as the case may be. In phlyctenular keratitis photophobia and blepharospasm are carried to a higher degree than in any other form of corneal ulcer. In severe cases the child is commonly seen with the lids tightly closed and with a fist over each eye, or with his face buried in the dress of the nurse who is carrying him. Any attempt to look at the eyes is met by violent spasmodic contraction of the lids, and if after severe struggles the lids are parted,

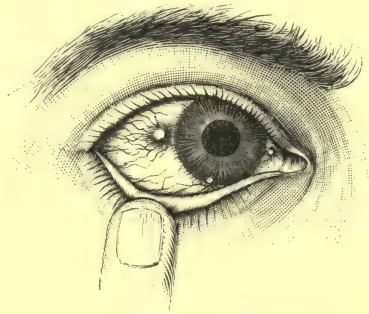


FIG. 87.—Phlyctenular ophthalmia.

the globe is found to be so turned upwards that it is impossible even to see the cornea unless lid retractors are used or the child given a few whiffs of chloroform. Symptoms are in fact out of all proportion to the apparent disease, and frequently there is little to be seen but one or two minute marginal phlyctenules. The severity of the symptoms is intensified by painful spasmodic contraction of the ciliary muscle, which is induced by the slightest exposure of the eye to light, and which in its turn increases the photophobia and blepharospasm. As a result of the latter, the tears get pent up between the lids, and then, gradually oozing over the face, produce superficial excoriations and eczema on the cheeks and linear cracks at the external commissure. In many cases there is some catarrhal conjunctivitis, whilst in others the nose is swollen with impetiginous incrustations about the alæ and upper lip. The temperature often shows an evening rise of one or two degrees, the skin is moist and clammy, the bowels constipated, and there is complete anorexia. The tongue is quite characteristic, always coated with a delicate white fur which gives it a creamy appearance.

Prognosis.—When the cornea is affected the case is apt to drag on for a long time, sometimes several months, now better, now worse, according to the child's state of health; but this state of things is often due to badly understood or misapplied treatment, and if the case is taken energetically in hand in the proper manner, it generally does well, and the ulcer is healed after a week or two, though recurrences may subsequently take place. With conjunctival phlyctenules, little difficulty is experienced, and they quickly disappear. The chief dangers in phlyctenular keratitis are the tendency to recurrences, by which vision may be ultimately much impaired from nebulae of the cornea, and, secondly, in the ulcer becoming purulent and perforating the cornea, in which case the eye will very probably be lost.

Treatment.—A great feature in the successful treatment of phlyctenular ophthalmia is the recognition that the disease is as much a constitutional as a local one; and great importance, therefore, attaches to the improving of the child's health. The general conditions under which the child lives should first be inquired into, and, particularly, these inquiries should embrace the questions of foul air from leaking drains, etc., and improper food. Treatment should be commenced by a week's course of a mild alterative administered nightly, such as the Pulv. Hyd. \bar{c} Creta, combined with a light and nutritious diet. At the end of this time the child's health will probably be much improved, the evening temperature will be normal, and the appetite better; and, if this be so, tonics, such as Scott's or Kepler's emulsions or Parrish's food, may be substituted and continued for a few weeks.

As regards local treatment, it is better, when symptoms are acute, to keep the child in bed, and when very young a cardboard splint should be bandaged on the flexor surface of each forearm, reaching above the elbow, so as to prevent the child from rubbing the eyes. The first thing to do is to obtain complete relaxation of the accommodation by placing a little of the Ung. Atrop. grs. iv ad $\bar{3}$ j between the lids three times daily until the pupils are widely dilated, when the frequency may be reduced. Strong and frequent applications are necessary to effect

relaxation in the first instance, and even with the above treatment it is often that a few days elapse before a marked effect is produced ; but as soon as the accommodation is paralysed there will be a very considerable improvement in the photophobia and blepharospasm. At the same time, the conjunctival sac should be washed out two or three times daily with the Lot. Ac. Borac., or if catarrhal conjunctivitis be present, the Lot. Hydrarg. Perchlor. (1 in 6000) should be substituted, and, if necessary, the lids painted with a solution of Argent. Nit. grs. v to grs. x ad 3j. A weak solution of mercury is preferable in these cases to the salts of zinc, which are apt to irritate the ulcer. The bandaging of one eye alone is never of any service in phlyctenular keratitis ; the eye is kept firmly closed by the blepharospasm, and this is maintained sympathetically by the use of the other eye, which the child is obliged to open now and then ; but if the child is kept in bed we have found the greatest benefit from lightly bandaging a wet compress over *both* eyes, which are thus excluded from light, whilst the wet compress speedily becomes warm, and acts as a soothing fomentation. We have never found any disposition in young children to resent the exclusion of both eyes ; but, on the contrary, the application of the compress is followed by a general improvement in temper and docility. In children over six years of age this method, however, is more difficult, and the best alternative is then to exclude light by means of dark neutral-tinted protectors. There are, however, a few most obstinate cases, generally those in which both eyes are affected, and in which the blepharospasm resists all the above detailed methods of treatment. In such, the best treatment is to divide the external canthi and orbicularis by a horizontal snip with scissors. The little operation is not attended by any danger, and has most beneficial results.

If a phlyctenular ulcer becomes purulent, the irrigation of the eye must be more frequent than above described, and fomentations should be assiduously employed. The presence of hypopyon does not of itself call for operative measures, as is generally the case with adults, for it is very frequently absorbed in children, and if hypopyon is present when the case first comes under notice, palliative measures will very frequently meet with complete success. If, on the other hand, the ulcer has developed in spite of treatment, and hypopyon appear as a fresh complication, the case is different, and the treatment should be according to the lines laid down on page 147.

When the corneal ulcer shows signs of healing and photophobia is diminished, stimulation by means of the Ung. Flav. Dilut. \bar{c} Atropina grs. iv ad 3j (F. 67) or the insufflation of a little powdered calomel often hastens the convalescence.

Cases of purely conjunctival phlyctenules with few symptoms are best treated by using stimulating treatment from the first, and under this they quickly disappear. There is no object in using atropine in these cases, and it should be avoided. The Ung. Flav. Dilut. (F. 66) may be massaged twice daily over the affected area, and the conjunctival sac kept clean by a mild boracic lotion.

Closely allied to phlyctenular ulceration are the efflorescences that appear at the limbus of the cornea in association with **Acne rosacea**.

They run a similar course and exhibit the same vascularisation of the cornea and tendency to frequent relapses as the phlyctenular formations of childhood. They form an exceedingly troublesome complication of acne rosacea, and fresh outbursts are to be expected whenever the facial condition becomes aggravated, so that in course of time the cornea may become pitted with vascular fasciculi and nebulæ, by which the sight is greatly impaired. Accompanying the corneal manifestations, there is always a chronic inflammation of the palpebral conjunctiva of the lower lid, the surface of which is roughened and injected, whilst the tarsal margin is thickened, and often exhibits one or more of the hyperæmic papules characteristic of the facial disease.

Treatment.—Stimulating ointments, such as the Ung. Flav. Dil., are very useful, as in phlyctenular ulcers, and generally give speedy relief. The conjunctivitis is best treated by painting twice weekly with a 10 grain solution of silver nitrate or the daily application of a 5 grain solution of the same drug, whilst in the intervals a weak alkaline lotion of bicarbonate of soda (F. 53) may be employed, or the Lot. Boracis c̄ Soda (F. 44). The treatment of the rosacea is of the first importance, and as this is largely dependent on chronic dyspepsia, special attention must be paid to dieting, etc. It will be found that the permanence and completeness of the cure of the eye trouble will depend upon the success that follows our endeavours to ameliorate the condition of the face.

FISTULA OF THE CORNEA.

A corneal fistula is a small opening in the cornea which has little or no tendency to close, and through which the aqueous humour is constantly oozing.

Causes.—1st. A perforating ulcer of the cornea which from some cause has been imperfectly healed.

2nd. A contused or lacerated wound of the cornea, after which there has not been perfect union.

3rd. A wound of the cornea with wound of the lens. The swollen lens pressing on the iris may keep up such constant irritation of the eye as to retard the union of the edges of the corneal wound.

4th. A glaucomatous state of the eye following a perforating wound of the cornea.

5th. The presence of a foreign body within the eye; the wound through which it entered having failed to completely unite.

Symptoms.—A shallow or scarcely perceptible anterior chamber, with a minute opening in the cornea, through which drops of the aqueous humour may be seen to exude. One useful method of diagnosing a fistula of the cornea is to separate the eyelids with the fingers from the globe, and having dried the suspected spot of the cornea with a piece of blotting-paper, to notice if the surface again becomes moist whilst the eye is kept open.

Treatment.—When dependent on a perforating ulcer or a wound of the cornea, the fistulous orifice may be touched with nitrate of silver. This is best applied by a fine camel's-hair brush which has been first

moistened with a little water and then drawn a few times across a stick of nitrate of silver. This application may be repeated three or four times at intervals of two days, if it does not excite undue inflammation. If this treatment fails, an iridectomy should be performed; the spot at which it is made is not of much consequence, as in any part it will succeed equally well in promoting the closure of the fistula.

When the fistula is due to a cataractous lens pressing on the iris which, by the irritation it excites, prevents the perfect union of the corneal wound, the lens should be removed. If, however, the maintenance of the fistula is caused by a glaucomatous state of the eye, an iridectomy should be performed. Lastly, if all other means have failed, the edges of the fistula may be pared with a broad needle, and united by a single fine silk suture.

VASCULARISATION OF THE CORNEA—PANNUS (*see* Fig. 72).—In many forms of corneal ulceration the process of repair is heralded by the formation of new vessels, which creep into the cornea from the limbus, and serve to carry off the products of disintegration and convey material for repair. A similar ingrowth of new vessels also occurs when trachoma attacks the cornea, and in interstitial keratitis; but in both these cases the pannus, whilst favourable to absorption, does not only occur during the retrogression of the disease, but is an early and peculiar feature of it.

Vascularisation may be confined to the superficial planes of the cornea, or may permeate its thickness. Superficial pannus is the variety especially associated with phlyctenular keratitis and trachoma, whilst interstitial keratitis is the disease in which deep vascularity is most commonly seen. In superficial pannus the vessels are derived from the subconjunctival circle round the limbus, and do not lie upon the epithelial surface, as at first sight they appear to do, but ramify underneath Bowman's membrane; whilst in pannus affecting the deep corneal planes additional offshoots are derived from the anterior ciliary vessels. In superficial vascularity, the contrast afforded by the surrounding grey infiltration, as well as the superficial position of the vessels, allows each vessel to be picked out as a separate red thread, a point that readily distinguishes the condition from deep pannus, in which the cornea assumes a more uniformly red and fleshy appearance.

Upon the completion of healing, the new vessels in both superficial and deep pannus become avascular and shrink, but, except in the case of the finest twigs, they never entirely disappear, and may be recognised years afterwards as a series of whitish interlacing threads; whilst, should a recurrence of inflammation occur, many of them will once more become active blood-channels.

Treatment.—For the treatment of pannus *see* the various affections by which it is caused; *also* "Chronic Vascular Fasciculus."

CHRONIC VASCULAR FASCICULUS.—This name has been applied to what is generally rather a vascular nebula than an ulcer; it is the remains of an ulcer which has become filled in, but in which the vessels originally destined for its repair have from some cause become stationary, and by their presence keep the eye in a state of constant irritation.

Symptoms.—Continued irritability of the eye, with lacrymation and dread of light, varying in intensity but never entirely absent. The history is generally that of an ulcer of the cornea which had recovered up to a certain period, from which date the eye had ceased to mend, and had since been more or less irritable. On examination a small nebula will be seen on the cornea at a short distance from its margin, with one or more vessels, sometimes a regular bundle of them, running up to it from the sclerotic adjoining the corneal edge. It frequently happens that the patient has been under treatment for many months, and sometimes even for two or three years, during which time he has persistently instilled drops into the eye, both stimulating and sedative in turn, but without gaining the slightest benefit from either.

Treatment.—This is one of those affections of the eye in which the use of the seton was formerly much advocated, but the treatment is now obsolete, and the day of setons has disappeared for ever.

A trial should first be made of stimulating remedies. The Ung. Flav. (grs. iv to grs. viij ad ʒj) should be gently massaged over the cornea night and morning for a minute or two, and the superfluity of ointment subsequently removed by gently washing out the eye in about twenty minutes with a mild boric lotion. Dusting a little calomel into the eye every other day, with light massage and irrigation as in the previous case, is also a useful method. The washing out of the conjunctival sac is important, because the irritative effects of stimulating drugs upon the conjunctiva are thereby limited, and their use tolerated longer and with less discomfort to the patient.

If the case does not progress, stronger means must be employed, and the fasciculus should, after cocainisation, be touched with the mitigated silver stick by drawing a wet camel's-hair pencil several times across the stick and then applying the former lightly along the vascular patch. One application is often sufficient, but the application may be repeated in a few days if necessary, the eye being kept bandaged during the interval. Another method is to split the vessels by longitudinal incision of the larger trunks, as adopted by Scott in dealing with the pannus of trachoma; or to obliterate them at the corneal margin, either as in the operation of peritomy, or by means of the galvano-cautery.

The state of the patient's health should be carefully watched, and any irregularity corrected. If possible, the patient should take three or four weeks' holiday and recreation, abstaining during this time from all forms of close work.

OPACITIES OF THE CORNEA.

NEBULA, OR CLOUDINESS, OF THE CORNEA may be caused by inflammation or superficial ulceration of the cornea, or by an injury which has induced a traumatic keratitis. It may be limited to a portion of the cornea, or it may be irregularly diffused over its whole surface. In some cases the nebula is due to an interstitial deposit of lymph in the true corneal tissue; whilst in other instances it is produced by a layer of fine semi-transparent cicatricial tissue formed during the healing process of a superficial ulceration.

Treatment.—When the eye is free from all irritation, some mild stimulating application will occasionally do good; but there are no specific remedies for the cure of nebula. The applications from which the most benefit may be expected are the following:

1. Massage of the cornea twice daily through the closed lids with the Ung. Flav. Dil. (F. 66).

2. The application of the constant current. This form of treatment has been little tried in this country, and we cannot speak of it from personal experience. Fuchs* speaks favourably of the treatment, and places the positive pole on the temple or neck, whilst the negative pole, which is made of silver, cup-shaped at its extremity so as to fit the cornea, is applied to the eye after cocainisation. Contact is effected by a drop of mercury, which adheres to the silver, and a weak current of 0.2 to 0.5 millampères is employed.

3. Dusting calomel into the eye every or every other day for a short time.

The loss of sight entailed by a nebula will of course largely depend upon its position with regard to the pupil, but even when the nebula does not trespass upon the pupillary area, much impairment of sight may be caused by changes in the corneal curvature which render the eye astigmatic. In such cases cylinders, and especially concave ones, often effect great improvement.

A *Stenopæic disc*, that is a wooden or metal diaphragm with a small central opening of 1, 2, or 3 mm. diameter, or cut with a central slit that may be set at any angle, sometimes improves the sight; but it is difficult to get patients to use spectacles thus fitted, on account of their hideous appearance; and in other cases they worry and fidget the patient, and are not tolerated for more than a short time. The aperture may be fitted with any lens that improves the patient's refraction.

When the opacity is central and sight thereby much impeded, and is unimproved by any of the above methods, an artificial pupil may be made opposite to that portion of the cornea which is most normal both as regards its transparency and curvature. The improvement that is likely to follow an optical iridectomy can be gauged in doubtful cases by the benefit derived from dilating the pupil with atropine. It is more often of service in cases of leucoma than nebula of the cornea. (For the method of performing the operation see "Artificial Pupil.")

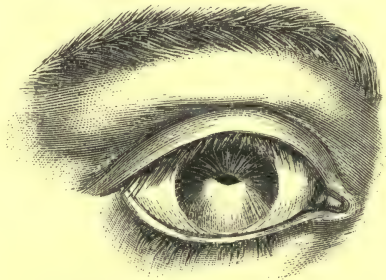


FIG. 88.—A leucoma of the cornea.
(After Dalrymple.)

LEUCOMA OF THE CORNEA.—A leucoma is a dense white opacity of the cornea caused by a loss or destruction of a part of its substance, the gap thus made being replaced by cicatrix-tissue, which is opaque and white, instead of transparent and colourless like healthy cornea. It may be the result of an injury, but

* 'Text-book of Ophthalmology,' 2nd ed., p. 211.

more frequently it is occasioned by inflammation and deep ulceration induced by other causes. It is irremediable. With the leucoma there is often some alteration in the shape of the pupil, from a portion of the iris having become adherent to the cicatrix. In such cases the ulcer which had caused the leucoma had penetrated the cornea, and the iris had either been dragged into the wound as the aqueous escaped, or else, falling forwards, had contracted adhesions to the granulations which were afterwards to be converted into cicatricial tissue.

When the opacity is extra pupillary a cylindrical lens may sometimes improve the sight, but when the leucoma trespasses on the pupil an optical iridectomy should be performed (*see* preceding section).

To lessen the defect in appearance caused by a leucoma, the white patch may be partially or completely tattooed black, according to its size and situation. In cases of central leucoma a circular pupil may be thus tattooed on the cornea, but this treatment is contra-indicated if there is adherent iris, which might become inflamed or be the means of transmitting septic organisms into the interior of the eye.

Operation for Tattooing the Cornea.—This is done by making a series of small punctures into the corneal tissue, and running into them a strong solution of Indian ink. The operation may be performed by a single-grooved needle fixed in a handle. A little Indian ink should be rubbed down on a palette and made sufficiently fluid to run easily after it has been placed into the groove of the needle by a camel's-hair brush. With the needle well charged with Indian ink a series of punctures are to be made close to each other over the whole area of the spot to be coloured. Each puncture of the needle should pass through the corneal epithelium into the true corneal tissue. Two or three sittings are generally required to make a good representation of a pupil on the leucoma.

The effects of the operation are not, however, permanent, and the tattooing must be repeated from time to time.

OPACITY OF THE CORNEA FROM LEAD is caused by the use of a lead lotion when the cornea is ulcerated or abraded; the lead is deposited on the surface as a carbonate, producing a milky-white patch, which is often sufficiently opaque to occlude either the portion of iris or the pupil which lies behind it.

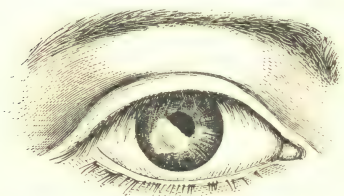


FIG. 89.—Gives a very fair representation of lead deposit on the cornea.

The **treatment** consists in removing the layer of lead deposit which has coated the abraded surface of the cornea. This may be done by the aid of a small Beers knife or a cataract needle. The lids being separated by a speculum, the operator with one hand fixes the eye with a pair of forceps,

whilst with the other he gently scrapes the whitened surface of the cornea until, having detached the epithelium, he comes down to the

thin coating of lead; steadily but gently scraping, he will generally succeed in detaching all that is required. A drop or two of olive oil should then be instilled, and the eye bandaged and kept under atropine for a few days, until all irritation has subsided.

TRANSVERSE CALCAREOUS FILM OF THE CORNEA—*Symmetrical Opacities of the Cornea*.—These terms have been applied to a peculiar form of opacity of the cornea caused by a deposit of the earthy salts in the anterior layers of the cornea beneath the epithelium.

The opacity commences as a greyish-white film in the neighbourhood of the palpebral fissure, and in its subsequent growth it always remains confined to this line, so that in course of years, for its progress is usually very slow, a transverse riband-like opacity stretches from one side of the cornea to the other. It is essentially a disease of old age, though it does occasionally occur in the prime of life. Both eyes are usually affected, and from its position the opacity causes much interference with vision. The disease is non-inflammatory, and gives rise to few subjective symptoms beyond loss of sight, and this, taken together with its peculiar configuration, the history, the age of the patient, and the characteristic granular appearance which is produced by minute collections of calcareous matter, makes the diagnosis easy.

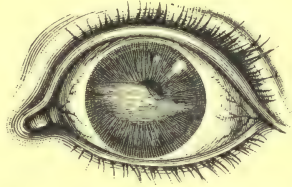


FIG. 90.—Transverse calcareous film of the cornea. (After Bowman.)

The **ætiology** is obscure. Often the eyes are otherwise healthy, and no cause can be assigned for the onset; whilst in other cases the eyes are much disorganised from the effects of long-standing glaucoma or irido-cyclitis. It seems most probable, from the position of the opacity and its non-inflammatory nature, that it is of trophic origin, and it may possibly be due to the same causes that promote the deposit of lime-salts in osteo-arthritic joints.

Treatment.—No medicine nor local application will stay the progress of the disease. When, however, the opacity has reached a sufficient density to interfere seriously with sight, an attempt should be made to remove it. The best plan, first adopted by Bowman in 1849, is to scrape away the epithelium of the cornea with the edge of a sharp knife or needle until it comes down upon the calcareous opacity, and then to detach by scraping and chipping as much of the film as possible. The result of this operation is often most satisfactory. In Bowman's case the man, owing to his defect of sight, had been thrown out of employment for twelve months, but after the film was removed he could see almost as well as he could eight years before, and could read with care the smallest type.

BLOOD-STAINING OF THE CORNEA is an occasional complication of a hæmorrhage into the anterior chamber. The appearance is that of an opaque rusty-brown patch of variable size, which occupies the central portion of the cornea, but never, except in the most recent cases, extends over the whole surface; so that a wide or narrow limiting ring of un-

stained tissue is almost always to be seen. When the hæmorrhage first occurs the corneal lamellæ are, as Collins* has pointed out, permeated throughout by colouring matter; so that at this stage the discolouration of the cornea cannot be recognised apart from the blood exuded into the anterior chamber; but after a time absorption of the staining material commences at the periphery of the cornea—the part most adjacent to vascular channels,—and thus a gradually widening ring of cornea that has regained its translucency bounds the still discoloured central area, and differentiates the corneal condition from the hyphæma. In the cases so far submitted to microscopical examination corpuscular elements have been completely absent, and the staining material found to consist of hæmoglobin which has become converted chiefly into hæmatoidin, a salt insoluble in the fluids of the cornea (Collins).

Diagnosis.—A point to be borne in mind is that a central patch of blood-stained cornea may closely resemble a very dark amber-coloured cataract or an anterior dislocation of the lens. The history and a careful examination will suffice to clear up the differential diagnosis.

Prognosis.—Absorption takes place but slowly, and it will probably be many months before the centre of the cornea regains its translucency.

Treatment.—No special line of treatment is indicated.

ARCUS SENILIS.

This is a term wrongly applied to a whitish crescent which frequently appears near but not quite up to the margin of the cornea, as beyond the white marking there is usually a clear rim of transparent cornea. It may begin at either the upper or lower margin of the cornea, and gradually extend until the whole cornea is surrounded. In old people it frequently assumes a dense white and almost chalky appearance.

It is due to fatty changes in the periphery of the cornea, but it has no pathological significance, and never encroaches on the pupillary area, and never interferes with vision. The arcus is not a senile change, as it is frequently seen in young healthy subjects under thirty, and it certainly does not point to degenerative changes in the heart or arteries, as has too frequently been asserted. We have known patients who have had a well-marked arcus for over thirty years and still enjoy good health. We have frequently seen a dense arcus surrounding the cornea in patients over eighty years of age, and with no evidence of cardiac or arterial disease; and we have seen an old patient with gangrene of both legs from arterial degeneration who had not a trace of an arcus. The presence of a pronounced arcus is no hindrance to an intra-ocular operation, as sections carried through it heal perfectly.

ECTASIES OR BULGINGS OF THE CORNEA.

CONICAL CORNEA—*Keratoconus*—is a staphylomatous bulging of the middle portion of the cornea, caused by a thinning of its structure in that region. The conicity is not always quite central, but frequently a

* 'Trans. Ophth. Soc. U. K.,' xv, p. 75.

little to one side of the pupil, and such cases give excellent results after a trephining operation, as only a portion of the pupil is affected by the leucoma which follows. The disease comes on very imperceptibly, and progresses without pain. It appears during the period of body growth, rarely occurring after thirty years of age, and is more frequently seen in females. It first manifests itself to the patient by a change in the focus of the eye, which becomes irregularly myopic; and this defect grows worse as the cornea bulges, until, in severe cases, the sight is so much impaired as to render the eye almost useless. Usually there is no undue vascularity of the globe, but in some instances where the conicity is rapidly advancing there is slight ciliary redness. The bulging may increase until the apex of the cone seems to be on the point of bursting; but this is an accident that seldom if ever occurs spontaneously. After the cone has attained a certain size its apex loses its transparency and becomes nebulous or semi-opaque, with its epithelial surface roughened. This nebulosity is explained by Hulke,* who found in one such case that the regular lamination of the cornea was replaced in the neighbourhood of the cone by a web of nuclear fibres and cells. One or both eyes may be affected; but when both are involved the conicity is generally much greater in one eye than the other.

The disease will frequently advance rapidly in one eye, whilst it remains stationary in the other.

Diagnosis.—In the advanced stage, conical cornea is easily recognised, but at the commencement of the disease it is often difficult to diagnose, and its presence may be easily overlooked. The cornea is best examined by looking at the eye from its outer side so as to see the cone in profile.

In the early stages, when no *obvious* cone is present, the condition may be recognised by the following tests:

1. *With the Mirror.*—*a.* The centre of the cornea appears as a dark ring.

b. On turning the mirror so as to throw light at different angles the side of the cone opposite to the light is darkened (Bowman's Test †).

c. The refraction is very irregular, myopic, and markedly greater in the centre than at the periphery of the cornea.

2. *With the Concave Mirror and Lens.*—The shape of the disc alters with every movement of the lens or of the observer's head, shifting in one direction and extending in another, and, further, is never seen acutely in its entirety (Donder's Test ‡).

3. *With the Keratoscope* (Placido's Disc, see "Astigmatism.")—The rings are distorted, and appear to be curved eccentrically.

Ætiology and Pathology.—It is very difficult to ascribe any cause for the structural changes in the cornea which give rise to the staphylomatous bulging. The tension of such eyes is seldom if ever in excess; indeed, it is more frequent to find them slightly soft. All that we are at present able to say of conical cornea is that from some cause, possibly failing nutrition or inherent weakness, the central portion of

* 'R. Lond. Opth. Hosp. Rep.,' vol. ii, p. 154.

† 'R. Lond. Opth. Hosp. Rep.,' vol. ii.

‡ 'Accom. and Refract. of the Eye,' p. 550.

the cornea becomes thinned and its power of resistance diminished, so that it yields before the normal pressure from within the eye and bulges conically.

Tweedy, * in an interesting paper from which we quote, points out, "That there are at least two embryological conditions which are favourable to the occurrence of conical cornea.

"1. The involution and subsequent detachment of the primitive crystalline lens from the epiblastic cells, which are the prototype of the corneal epithelium, involve a temporary breach in the continuity of the epiblastic corneal layer.

"2. The mesoblast which is to form the foundation of the fibro-cellular element of the cornea creeps in from the periphery and encroaches centripetally, so that eventually the apices of the advancing columns of cells meet in the centre of the cornea and coalesce. . . . If a check occurs at this stage, the centre of the cornea is incompletely evolved, and is therefore left more or less permanently weak. . . . It is this element which I believe does obtain in all cases in which conical cornea supervenes, and is the essential predisposing factor. A third element of weakness is to be found in the distribution of the nutritional supply from the circumference to the centre."

In support of this hypothesis, Tweedy points out that conical cornea is often associated with other developmental defects in the eyes, teeth, and skin, and also that the disease is often inherited, and affects certain families.

Treatment.—When conical cornea is in its earliest stage it is possible that by judicious prophylactic treatment its progress may be retarded; but when the cone is steadily advancing no help except by operation is likely to be of any avail.

As preventive treatment, all work which strains or reddens the eyes should be avoided. The cold or tepid douche, whichever is the more pleasant, may be used three or four times daily. When there is any ciliary redness, two or three leeches may be advantageously applied to the temple. If the patient is feeble, tonics of quinine, iron, etc., should be ordered. Except in the very commencement of the disease, but little if any benefit will be derived from either concave, spherical, or cylindrical glasses. The astigmatism produced by the conicity is so irregular that it cannot be sufficiently corrected by lenses to afford much improvement of sight. Occasionally a stenopæic slit placed behind a concave spherical lens is found of decided service, and when this is the case the patient may be provided with similar spectacles, but with the understanding that they must be laid aside if they fatigue the eyes.

Operative Treatment.—The method now adopted for the relief of cases of advanced conical cornea is to remove the apex of the cone, and afterwards, if the leucoma which follows impedes the sight, to make an artificial pupil opposite to that portion of the cornea which has the most normal curvature.

There are three operations for the removal of the apex of the cone, all of which have been followed by very excellent results:

* 'Trans. Ophth. Soc. U. K.,' vol. xii, p. 67.

1. *The excision of an oval piece of the cone*, the length of the oval being made at right angles to the meridian of highest refraction.

2. *The excision of a circular piece of the cone* with a small cutting trephine, as suggested by Bowman.

3. *The destruction of the apex of the cone with the electro-cautery.* Some surgeons prefer to stop short of perforating the cornea, but Tweedy, with whom we agree, considers the opening of the anterior chamber an important feature. Both methods have given good results.

1. Operation for the Excision of a Small Oval Piece of the Cone of the Cornea.—Before operating, a solution of atropine (F. 10) should be dropped into the eye, so as to have the iris under its influence when the operation is completed; and thus to get the pupil dilated as soon as the aqueous is again retained within the anterior chamber.

After cocainisation a speculum is introduced, and the eye held firmly by a pair of finely-toothed forceps whilst a Graefe's extraction knife is passed through the apex of the cone, and so directed as to cut a small flap of the cornea not exceeding one-eighth of an inch in length and one-twelfth of an inch in width. This is to be seized by a pair of iris-forceps, and cut off by a pair of scissors. The cut edges of the cornea should then be allowed to fall together, and a pad of aseptic dressing is then placed over the closed lids and secured in its place by a compress bandage. After twenty-four hours the pad and bandage may be changed, but the lids should not be opened to look at the eye until at least forty-eight hours after the operation.

A solution of atropine (gr. iv ad aq. ʒj) may now be dropped inside the lower lid, and repeated once or twice daily, so as to keep the pupillary edge of the iris away from the corneal wound.

2. Operation for the Excision of a Small Circular Piece of the Cone of the Cornea by a Trephine.—This operation was first suggested and practised by Bowman.

Its object is to remove the most prominent part of the cone, and by the contraction caused by the healing of the wound to restore the curve of the cornea to a more normal state. The trephines vary in diameter so as to remove portions of different sizes, as may be requisite. They are provided with a movable "stop" to regulate the depth of penetration. The trephine usually required is one-tenth of an inch in diameter (Fig. 91).

After the eye has been placed under cocaine a speculum is introduced between the lids, and the trephine, adjusted by the "stop" to the depth it has to penetrate, is applied firmly to the apex of the cone and rotated with the finger and thumb. The trephine is not to be carried through the entire thickness of the cornea, but withdrawn when it may be calculated to have reached Descemet's membrane. The circular piece of cornea which has been thus cut is then seized by iris forceps and peeled off, but if it cannot be



FIG. 91.—Corneal trephine (medium size).

thus readily detached, it may be severed with a few touches of a cataract knife. A few drops of atropine should now be instilled into the eye, and the lids closed with an aseptic dressing and a bandage. One operation is usually sufficient to produce such a change in the curve of the cornea as to greatly improve the sight, but if necessary the trephine may be again applied after an interval of some months.

3. Removal of the Apex of the Cone by the Electro-cautery.—The cautery should be kept at a dull red heat, and quite a small point employed. Perforation is signalised by a sudden jet of aqueous, which immediately cools the cautery and annuls all danger. A pressure bandage should be then applied and maintained until the chamber has re-formed, which probably will not occur for some days. This is the simplest and easiest method of treating conical cornea, and furnishes as good a result as either of the two former procedures.

After each of the above measures a leucoma is formed at the site of operation, which, if centrally placed, greatly nullifies the improvement in vision that would otherwise result from the flattening of the cornea. It is therefore sometimes necessary to perform an iridectomy at a later date to make an artificial pupil; and care should be taken to place it opposite to that part of the cornea that presents the most normal curvature. No iridectomy should, however, be performed until some months at least have elapsed since the first operation, as a great deal of absorption of the central opacity may take place and render further measures undesirable.

As regards the amount of improvement to be expected from operation, no definite promise should be held out to the patient; as even after a most successful operation the astigmatism may be so irregular that lenses fail to give anything like acute vision. On the other hand, it is not uncommon for patients to see $D = \frac{6}{12}$ and Jaeger No. 1 with correcting lenses after treatment.

KERATO-GLOBUS—*Buphthalmos*—*Congenital Glaucoma*.
See "Congenital Glaucoma."

CORNEAL STAPHYLOMA is a forward projection or bulging of the new tissue which supplies the place of true corneal substance when a part or the whole of it has been destroyed by injury or disease.

A staphyloma of the cornea may be either *partial* or *complete*, that is to say, it may be limited to a small portion, or it may involve the whole of the cornea or the new structure which represents it.

PARTIAL STAPHYLOMA OF THE CORNEA.—When a portion of the cornea has been destroyed by sloughing or ulceration its place is made good by cicatricial tissue, which is more or less white or opaque, and in many cases is incapable of resisting the normal outward pressure of the parts within the eye; slowly yielding, it bulges and forms an unsightly prominence on the cornea.

Treatment.—The objects to be accomplished are: first, to arrest the progress of, and, if possible, to diminish the projection; and, second,

to restore some of the lost sight to the eye. Both of these conditions may be often attained by the operation of iridectomy.

The removal of a piece of the iris by iridectomy exercises an important influence in diminishing the tension of the globe, and thus frequently prevents any further increase of the staphyloma. But, in addition to this, by the excision of a portion of the iris opposite to that part of the cornea which is in the most healthy state, an artificial pupil is made, and if the fundus of the eye be sound, and the transparency and curvature of the cornea opposite the new pupil tolerably good, useful sight will be regained.

If, in spite of iridectomy, the partial staphyloma be large or increasing in size, a small circular piece of its most projecting part may be removed with the trephine (Fig. 91).

COMPLETE STAPHYLOMA OF THE CORNEA is a bulging of the *entire* structure which has replaced the original cornea after it has been destroyed by ulceration or sloughing.

Formation of the Staphyloma.—After the loss of the cornea, the exposed surface of the iris is soon coated with a film of lymph; this becomes organised and ultimately converted into a bluish-white cicatricial tissue, with which the iris is closely incorporated. The eye will now either gradually shrink, or the new tissue will yield before the pressure from within and become staphylomatous.

Treatment in the Early Stages.—If the patient be seen early, the first object in view is to prevent the formation of the staphyloma, and this is best accomplished by the removal of the lens, if it has not already escaped from the eye. After the slough of the cornea has separated, the lens will be often seen lying in the centre of the pupil, perfectly transparent, and projecting slightly forwards; it may then be removed by gently lifting it away with the point of a fine needle.

If the eye be not seen until a later period, but when the staphylomatous bulging is still recent, and the new tissue which occupies the corneal space is yet but imperfectly formed, the plan recommended by Bowman for the removal of the lens may be adopted. A broad needle is passed through the most prominent part of the staphyloma in the direction of the lens, so as to penetrate its capsule, and the lenticular matter is freely broken up. The needle is then withdrawn, and through the aperture it has made a curette is introduced, and as much of the lens matter as is sufficiently soft and diffuent is allowed to escape from the eye along its groove. The puncture made with the broad needle may be repeated every two or three days until the prominence of the staphyloma is reduced.

Treatment of Complete Staphyloma after Formation.—The eye being lost for all visual purposes, the objects to be accomplished are to



FIG. 92.—Staphyloma of the cornea. (From a specimen in the Royal London Ophthalmic Hospital Museum.)

The interior of the staphyloma is lined by atrophied iris.

get rid of the unsightly staphylomatous bulging, and to enable the patient to wear an artificial eye. One of the following modes of treatment may be adopted:

1. *The staphylomatous eye may be excised.*

2. *Mules' modification of the operation of evisceration may be performed.*

3. *The staphyloma may be trephined.*

1. *Excision.*—When the eye is blind and the bulging large and unsightly, and causes the patient annoyance from the obstruction it offers to the free movements of the lids over it, this is the best operation. The patient will recover from it more quickly than from any other, all chance of future trouble is avoided, and an artificial eye can be worn.

This operation may be supplemented by the insertion of a glass globe into Tenon's capsule (*Frost's operation*).

2. *Mules' operation* has practically taken the place of the original operation of evisceration. The merits and demerits of Mules' operation and its technique are discussed elsewhere, and all that need be said here is that no class of cases is better suited for the operation.

3. *Trephining.*—When the object is simply to reduce the size of the staphyloma, but not to form a bed upon which an artificial eye can be worn, the operation of trephining is well suited. A small circular piece of the most prominent part of the staphyloma may be removed by the trephine (Fig. 91) as described in the operation for conical cornea (page 169). If the lens be seen through the small opening thus made, its capsule should be pricked with a fine needle and the lenticular matter broken up, and as much of it as will come away be allowed to escape along the groove of a curette. The lids should be then closed and covered with a wet compress and bandage.

Abscission of the Staphyloma.—The description of this operation, which consists in the detachment of the protrusion with knife and forceps and the closure of the gaping wound with sutures, is omitted, as it should not in our opinion be performed. We have known cases in which sympathetic symptoms have arisen in the sound eye from the irritation caused by the recurrence of inflammation in the stump of the one that had been abscised.

KERATECTASIA.—This term is applied to a bulging of the cornea which is limited to the cornea and is composed solely of corneal tissue. This serves to distinguish the condition from corneal staphyloma, which always contains iris and is composed of granulation tissue.

Kerat ectasia, like staphyloma of the cornea, may be partial or complete. It is most commonly seen as the result of severe interstitial keratitis or corneal trachoma of long standing. The protrusion never assumes the unsightly proportions of staphyloma.

Treatment.—The only treatment likely to be of any avail is an iridectomy, by which the nutrition of the eye is improved. As a means in some cases of improving sight, it should be placed opposite to that part of the cornea where the opacity is least dense; but in many cases the operation is of but little service in this respect.

INJURIES OF THE CORNEA.

FOREIGN BODIES ON THE CORNEA OR ON THE CONJUNCTIVA LINING THE LIDS.—**Symptoms.**—Great irritability of the eye accompanied by a copious flow of tears, an almost absolute inability to raise the upper eyelid and face the light, and a distinct feeling of grittiness as if something were in the eye. The suddenness of the attack and the exposure to which the eye has been subjected are also points to be noted.

Treatment.—To examine an eye which is suspected to be suffering from the presence of a foreign body, the patient should be made to sit in a chair with his face towards a window, so that a good light may fall upon the eye. The lower lid should be first drawn down, and if any particle of dust or chip of iron is seen it can be readily removed. Next the cornea should be carefully scanned over by turning the head of the patient in different positions, so as to cause the light to fall obliquely on the eye, first on one part of its surface and then upon another; or by using a convex lens of + 12 D a column of light may be directed over the cornea so as to illumine each portion of it in succession. Often it is exceedingly difficult to detect a fine spiculum of steel or a fragment of glass, or indeed any minute shining substance which may have been impacted on the cornea. In cases of doubt or difficulty the question may be settled by taking the patient into a darkened room and examining the corneal surface by oblique illumination with ophthalmoscopic light. Should the cornea be free, the under surface of the upper lid should be then examined.

To evert the upper lid, the surgeon, standing either behind or in front of the head of the patient and directing him to look down, seizes with his left finger and thumb the lashes of the eyelid, and drawing them slightly away from the globe, he at the same moment with his right hand presses the end of a probe or the tip of his right forefinger on the integument of the lid downwards and forwards, so as to tilt the upper edge of the tarsal cartilage downwards, and by this manœuvre to evert it. One finger of the left hand is then made to gently press the turned-up edge of the lid against the brow, to maintain it in its everted state, whilst the patient continues to look down so as to expose as fully as possible the oculo-palpebral fold of mucous membrane which extends from the posterior edge of the cartilage on to the eye, as shown in Fig. 93. The under surface of the lid thus exposed may be then carefully inspected, and the cause of the irritation, if any is found, be removed.

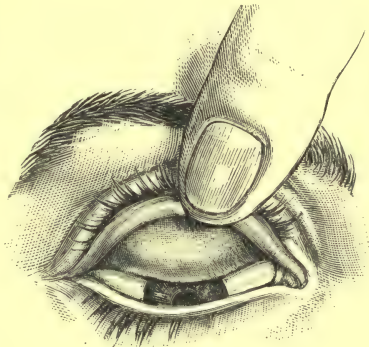


FIG. 93.

If the foreign body is not deeply buried, but is either lying on the surface or slightly sunk into the epithelium of the cornea or conjunctiva of the lids, it may be easily removed by a spud (Fig. 94), or by a corneal gouge (Fig. 95).

If the foreign body is buried deeply in the corneal tissue, a broad needle should be passed into, but without penetrating, the cornea; inserting it just by the side of the object, it should be made to traverse the corneal lamellæ until the broad part of the blade is behind the foreign body, when, by thus giving a firm support upon which to act, another needle may be fearlessly used to pick gently from the surface until it reaches the object, which can then be lifted away. Should, however, the foreign body have so deeply penetrated the cornea that it is feared any attempts to reach it from its surface may end in pushing it into the anterior chamber, a broad needle should be passed into the anterior chamber and pressed against the inner surface of the cornea immediately behind the foreign body, and carefully and steadily held in this position whilst the surgeon, with another needle, scrapes through the cornea, layer after layer, until he reaches it.

Having removed the foreign body, a solution of atropine (grs. ii ad ʒj) should be instilled, and the eye kept tied up until all symptoms of irritation have disappeared. Two or three times a day the bandage should be removed for gentle injection with some simple soothing lotion (F. F. 37, 48), and the occasional use of atropine is advisable until the healing is completed.

Should inflammatory symptoms supervene, the case must be treated on the lines laid down in discussing the "Treatment of Corneal Ulcers" (page 144).



FIG. 94.—Corneal spud.

ABRASIONS OF THE CORNEA.—An abrasion of the cornea is the forcible removal of a portion of the epithelium from its surface. It is always the result of an injury.

Symptoms.—Immediately after the accident there is photophobia, great lacrymation, and conjunctival redness, with a feeling as if a foreign body were in the eye. On examination of the eye with a good light, the abrasion will be recognised by the glistening facet, which will be seen at the part where the cornea has been denuded of its epithelium.

Prognosis.—Favourable in a healthy person; but in a delicate or exhausted patient ulceration of the cornea, diffuse suppurative keratitis, and ultimate loss of the eye may be caused by this apparently slight accident. Abrasions of the cornea frequently occur in mothers who are suckling; the child unconsciously claws at the eye, and scratches off a little of the epithelium from the cornea. As the health of the mother during lactation is often very unfavourable for the repair of injuries, very severe inflammation may follow, which may lead to complete destruction of the eye.

Treatment.—This is precisely similar to that advised in the preceding section when an abrasion has been caused by the surgeon in removing an embedded foreign body.

When abrasions of the cornea take on unfavourable symptoms, as they frequently do, it is usually on account of some condition of the patient's health specially unfavourable for the repair of injuries. Too great plethora, anæmia, a constitution broken by drink and rough living, or one enfeebled from some exhausting cause, such as suckling, may retard recovery or induce symptoms dangerous to the eye. Such conditions of system must regulate our constitutional treatment. In the one class of cases moderate antiphlogistic treatment will be called for, whilst in the other the patient must be sustained by stimulants, and all irritation be allayed by sedatives. Opiates in these cases are of the greatest service, and a few minims of the *Liq. Opii Sedativ.* combined with *Liq. Cinchonæ* given three or four times a day will sometimes completely change the character of the inflammation, and induce a healthy action and a speedy recovery. If it should be preferred to give the opiate in one dose at night, it should be sufficient in quantity to produce sleep, as a single moderate dose will excite rather than tranquilise.

PENETRATING WOUNDS OF THE CORNEA.—In the majority of cases the corneal wound becomes of minor importance in comparison with the injury inflicted upon adjacent structures—the lens, the iris, or the ciliary zone;—such injuries will therefore be found treated under the articles headed (a) “Traumatic Cataract;” (b) “Prolapse of the Iris;” and (c) “Wounds of the Cornea and Sclerotic.”

Non-complicated penetrating wounds of the cornea should be treated with a pressure bandage and gentle irrigation twice daily until firm union is secured, which will generally have taken place in a week in clean-cut wounds. It is best to use atropine for a few days until all danger of inflammation has passed.

TUMOURS OF THE CORNEA.

Primary tumours of the cornea are of great rarity.

EPITHELIOMA.—A few cases have been recorded, but epithelioma of the cornea is so rare that instances must be regarded as pathological curiosities. Enucleation of the eye is the only possible treatment after a positive diagnosis has been made.

CORNEAL CYSTS.—Implantation cysts sometimes occur in the cornea in the same way as they are produced in the iris (*see* “Cysts of



FIG. 95.—Corneal gouge.

Iris”), and they are similarly lined by laminated epithelium (Collins).* The cyst may be so small that it is invisible to the naked eye, or it may form a bulging prominence which simulates a true corneal staphyloma, the differential diagnosis being perhaps rendered still more difficult by the presence of iris adherent to the site of the originating wound, as in a case related by Collins.†

CORNEAL HORNS.—The granulation tissue derived from the iris, by which a perforation of the cornea is healed (pseudo-cornea, *see* page 143), may very rarely become protuberant in a manner corresponding to the condition known as “proud flesh” in other parts of the body,

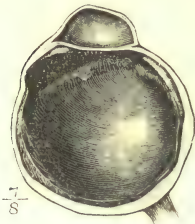


FIG. 96.—Cyst of the cornea. (From a specimen in the Royal London Ophthalmic Hospital Museum.)

The healthy cornea on the left is seen split into two layers by a large cyst.



FIG. 97.—A corneal horn.

The patient was an hydrocephalic idiot (*vide* ‘Trans. Ophth. Soc. U. K.,’ vol. xx).

and with the result that in an extreme case, as that depicted in Fig. 97 a conical excrescence is formed, the outer layers of which, by exposure to the air, etc., become welded into a hard cake resembling an epithelial horn in density, whilst the inner strata are soft and fleshy.

The cornea is frequently involved **secondarily** in epitheliomatous and melanotic tumours of the conjunctiva, for which the conjunctiva near the corneal margin is a favourite starting-place (*see* page 131), and a sarcoma or caseating tubercular tumour of the iris may also make an exit from the globe by perforation of the cornea.

The corneo-scleral margin is also an occasional site of **dermoids** (*see* page 129).

* ‘Anat. and Phys. of the Eye,’ p. 77.

† Loc. cit.

CHAPTER XII.

DISEASES OF THE SCLEROTIC.

ANATOMY.—The sclerotic invests the posterior five-sixths of the globe, and is composed of dense, pearly-white, fibrous tissue, almost avascular in character. It is thickest posteriorly, becoming gradually thinner anteriorly until the insertions of the recti muscles slightly increase its thickness again near the cornea. Its insertion into the latter is oblique, the most superficial fibres being inserted last of all, so that the two structures are, as it were, dovetailed the one into the other. Close to its junction with the cornea an important venous channel, the *canal of Schlemm* (see Fig. 104), forms a vascular ring round the cornea, whilst at the apparent corneo-scleral margin it is pierced by the anterior ciliary arteries and veins on their way to and from the iris. The choroid is only loosely attached to the sclerotic by wide-meshed areolar tissue, except at the site of the optic nerve and over the region of the ciliary muscle, leaving elsewhere a considerable lymphatic space known as the *peri-choroidal space*. Externally the sclerotic is enveloped by loose areolar tissue—the episcleral tissue,—which separates it anteriorly from the conjunctiva, and serves as a lymph channel.

At the site of the optic nerve the fibrous tissue becomes split up into a network of interlacing bundles (*lamina cribrosa*), leaving a series of fine sieve-like apertures, through which the bundles of the optic nerve make their way into the globe. In this neighbourhood also the long and short ciliary arteries and the ciliary nerves pierce the sclerotic, whilst just behind the equator of the eyeball emerge the large *venæ vorticosæ* from the choroid.

INFLAMMATION OF THE SCLEROTIC—EPISCLERITIS, AND SCLERITIS.

On account of its poor vascular supply, the sclera is rarely the source of a primary acute inflammation; but it is very apt to become secondarily involved by the extension of an acute inflammation

originating in the loose overlying episcleral tissue, or in the uveal tract. When the inflammation spreads from the episcleral tissue, it is spoken of as an *episcleritis*, whilst the term *scleritis* is used to define an inflammation beginning in the deep planes of the sclera adjacent to the uveal tract. The differentiation is important, both pathologically and clinically. In episcleritis we have an affection which, though serious enough in itself, still rarely if ever threatens the integrity of the eye, because it is chiefly superficial, and only involves the sclerotic to a limited extent; but in scleritis the inflammation is closely bound up with that affecting the most vascular and nutritionally important portion of the eye, and in consequence the inflammation may be of serious import and lead to atrophic changes, which are manifested by thinning and staphylomatous bulging of the affected area.

EPISCLERITIS.

Inflammation of the episcleral tissue shows itself as an ill-defined swelling, which is almost invariably situated to the outer side of the cornea, and usually behind the zone corresponding to the ciliary body. The reason why this is so constantly the affected region is difficult to understand; but probably one reason for it consists in the outer portion of the globe being more exposed to the effects of wind and weather than the inner, which, to a certain extent, is guarded by the projection of the nose. In favour of this view is the rheumatic character of the affection, which is very liable to recur, and which is seen with greatest frequency in those who are predisposed to rheumatism or gout. The patients are usually adults, and, as a rule, only one eye is affected at a time, though a recurrence may appear in either eye. In many cases some manifestation of rheumatism or gout is present in some other part of the body when the episcleritis makes its appearance.

Symptoms.—The swelling presents a patch of congested and chemosed conjunctiva surrounded by large swollen vessels, and exhibiting in addition a deep-lying dusky or violet area, quite different from the bright red of the superficial conjunctival inflammation, and due to congestion of the sclerotic coat. On palpation the swelling is felt to be hard and nodular, and it is very tender to the touch. Surmounting the swelling there is very often to be seen a translucent buff-coloured or whitish patch, usually about the size of a hemp seed, which at first sight closely resembles a large conjunctival phlyctenule, and which is due to some inflammatory obstruction in the superficial lymphatic circulation. Subjectively there is usually a considerable amount of dull aching pain, but its degree is variable, and some patients make but little complaint.

The onset is sudden like other rheumatic affections, and its duration variable. Sometimes under energetic treatment the swelling will subside in ten days or a fortnight; but more commonly it is three to five weeks before it has disappeared. It shows little tendency to progress after the first day or two, and it never breaks down. It always remains comparatively superficial, and never leads to any of the atrophic changes seen in scleritis.

An evanescent form of episcleral inflammation, attacking one or both eyes, and running its course in a few days, is that described by Fuchs under the name of **Episcleritis Periodica Fugax**. It is much rarer than the type already discussed, and is characterised not only by its transient character, but by its tendency to frequent recurrences, which may appear at varying intervals spreading over several years. The patients are usually elderly, and often give a gouty or rheumatic history.

Treatment.—The local application of hot soothing lotions, and the internal administration of salicylate of sodium and iodide of potassium give the best results in the acute stage of the disease. The eye should be allowed to soak in a warm solution of poppy heads (F. 8) or belladonna (F. 7) for a few minutes four or five times a day, and in the intervals it may be kept tied up with a wet compress dipped in the lotion. As soon as the inflammation begins to subside and pain and tenderness have disappeared, the salicylate treatment should be discontinued and tonics substituted, such as strychnine, with which a little iodide of potassium may be combined, or a mixture containing quinine and iron. Exposure to cold or wet should be carefully avoided throughout; and during the convalescent stage, and for some time afterwards, protecting glasses well curved round the sides and lightly tinted should be worn out of doors.

SCLERITIS.

As cyclitis is by far the most frequent form of inflammation of the uveal tract, so it is the ciliary zone of the sclerotic that is most commonly affected in scleritis, and it is over this region that we most commonly meet with staphylomatous bulging (ciliary staphyloma) as the result of its involvement.

In a minor degree the area of sclerotic immediately adjacent to a patch of cyclitis nearly always shares in the inflammatory processes going on around it, but if the cyclitis runs a mild course the scleral inflammation usually subsides in the same manner without any serious consequences. If, on the other hand, the cyclitis is very acute, becomes chronic, or fresh attacks occur, then, proportionate to the damage inflicted on the ciliary body is the effect likely to be manifested in the sclerotic, and its loss of vitality is exhibited by inability to resist the intra-ocular pressure, and the appearance of a protrusion over the site of disease. The bulging, once initiated, is often favoured by a heightened tension of the eye, which results from the ciliary inflammation, and in this way the affected portion of sclerotic may be reduced to the thinness of paper, and form a swelling too great to be completely exposed when the lids are open.

Symptoms.—No special train of symptoms other than objective signs can be ascribed to scleritis. We note its advent by the dark purplish hue which the band of inflamed sclerotic assumes, and in severe cases there is already in the acute stages a distinct swelling over the affected area, which may subside with the inflammation or remain permanent. In addition, severe cases are often complicated by the

appearance of deep infiltrations, spreading from the affected area into the adjacent corneal planes (**Sclerosing Keratitis**). These spread out from the corneal limbus towards the pupil as dull white irregular plaques, indistinctly circumscribed, and causing the normal clearly cut corneo-scleral margin to appear jagged and confused. The infiltrations tend to only partially disappear with the subsidence of inflammation; very often the sight is permanently impaired, and in any case they leave an indistinctness and irregularity of outline about the limbus which at a future date clearly indicates the affection from which the patient has suffered.

Beyond these features the symptoms of scleritis are so merged in those caused by the primary uveal inflammation that they cannot clinically be distinguished. If the swelling is severe, we may be sure that the sclerotic is seriously implicated, and must be prepared for subsequent atrophic processes to appear; but when this is not the case, we can only judge of the extent of damage by the length of time that the inflammation has continued, or the subsequent appearance of a staphyloma.

The treatment of scleritis and sclerosing keratitis is intimately bound up in that adopted for the primary inflammation (*see* "Cyclitis"), and if we can subdue this we are doing the best to combat any ill-effects that may result from the affection of the sclerotic.

(For the treatment of *Ciliary Staphyloma* *see* page 182.)

STAPHYLOMA OR ECTASIA OF THE SCLEROTIC.

This may be *complete* or *partial*.

By **Complete Staphyloma** is understood a bulging of the entire sclerotic coat, so that the eyeball is largely increased in size and protrudes between the lids. As the sclera gives way it becomes proportionately attenuated, so that the dark uvea can be seen through it, and its normal pearly-white colour is replaced by a mottled bluish hue. Complete staphyloma is the result of a long-continued increase in the intra-ocular tension, but even under such circumstances the toughness of the sclerotic will prevent a uniform bulging of this sort in the fully matured tissue of an adult, and consequently the condition is only found in young children who are the subjects of congenital glaucoma (buphthalmos).

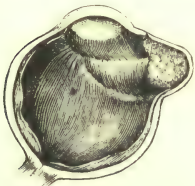


FIG. 98.—Anterior or ciliary staphyloma (*see* Text). (From a specimen in the Royal London Ophthalmic Hospital Museum.)

Complete staphyloma is irremediable, and the only treatment consists in removing the eye if the protrusion is unsightly or painful, or if inflammation has been set up in the exposed portion of the globe.

Partial Staphyloma is divided into—

(a) *Anterior or Ciliary Staphyloma*, (b) *Equatorial Staphyloma*, and (c) *Posterior Staphyloma*.

a. **Anterior or Ciliary Staphyloma** (Fig. 98) is a projection of the sclerotic in the ciliary region. It consists of a series of grape-like bulgings, with so much thinning of the sclerotic that

the dark colour of the ciliary processes with which they are in contact is seen distinctly through them. It may be limited to a part, or in severe cases may involve the whole, of the ciliary region, but wherever it extends the swelling is closely followed and lined internally by the atrophied remnants of the corresponding portion of the ciliary body. In rare cases the protrusion is confined to the narrow space that lies between the anterior extremity of the ciliary body and the limbus of the cornea, which is occupied by the root of origin of the iris, and contains the canal of Schlemm. This variety is known as an **Intercalary Staphyloma**, and in Fig. 99, which represents this condition, the above-mentioned space is seen to be enormously enlarged and converted into a cup-shaped cavity, which lies altogether anterior to the main portion of the ciliary body, and is lined by the drawn-out and attenuated root of the iris.

b. Equatorial Staphyloma (Fig. 100) is a protrusion of the sclera behind the ciliary processes in the region of the equator of the eyeball.



FIG. 99.—Intercalary staphyloma (see Text). (From a specimen in the Royal London Ophthalmic Hospital Museum.)

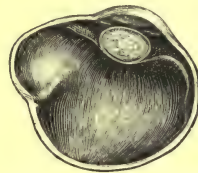


FIG. 100.—Equatorial staphyloma (see Text). (From a specimen in the Royal London Ophthalmic Hospital Museum.)

It forms a bulging of a similar appearance to a ciliary staphyloma, but it never encircles the globe, and is generally only noticeable when the eye is rotated to the opposite side.

c. Posterior Staphyloma, or the protrusion of the sclera at the posterior pole of the eye, is the condition so frequently associated with high myopia. Its importance lies in the bearing it has on the symptoms and progress of myopia, and it has been already discussed in dealing with this disease (see page 65).

Ætiology of Ciliary and Equatorial Staphylomata.—The protrusion may be the result of *disease* or *injury*. In the majority of cases it is dependent upon a chronic cyclitis or cyclo-choroiditis, accompanied by a gradual wasting of the sclerotic, so that it loses its normal power of resisting the outward pressure from within the eye, and, slowly yielding, forms a dark irregular nodulated prominence (see also "Scleritis"). As the *direct* result of an injury, the staphyloma may be produced by a rupture of the sclerotic, especially when there is also associated with it an extensive prolapse of the iris and choroid. The ciliary variety is certainly much more common than the equatorial,

because the ciliary region is a highly differentiated portion of the eye, and is much more frequently the chief focus of disease. One factor in the determination of the ciliary zone and the equator as special points for protrusion to take place may be that they mark the sites where the anterior ciliary vessels and the large venæ vorticosæ respectively traverse the sclera, and so form zones of weakness (Fuchs).

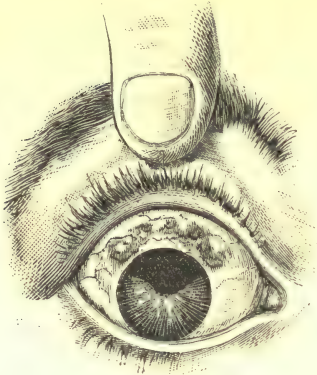


FIG. 101.—External appearance of a ciliary staphyloma.

In this case the staphyloma was caused by an injury causing rupture of the sclerotic and dislocation of the lens beneath the conjunctiva. The upper part of the iris has been torn away by the lens.

The Prognosis of ciliary and equatorial staphyloma is always most unfavourable—its mere presence implies that there is considerable impairment of vision;—but the danger to be apprehended is that it will increase, and as it enlarges all sight will be destroyed.

Treatment.—When the staphyloma is dependent on *disease* it may frequently, in its early stages, be arrested by the operation of iridectomy. Iridectomy acts in two ways: in the first place it reduces the intra-ocular tension, and secondly, in affecting this reduction it improves the nutrition of the eye. In favourable cases the tendency of the staphyloma to increase is certainly diminished, and in some instances completely stopped. It should be remembered that even though the tension of the eye at the time of the operation may be normal, yet the resisting power of

the sclerotic has been lowered by disease, and that by lessening the tension which exists the condition of the eye is improved.

If, however, the ciliary staphyloma is produced by a rupture of the sclerotic, we know of no remedy. The sight which such an eye retains, even when the staphyloma is small, is usually very limited; but if the bulging be sufficiently large to interfere with the free movements of the lid, the eye is generally blind. When an eye thus completely lost for all visual purposes is unseemly in appearance, and troubles the patient, the best treatment is to excise it.

INJURIES OF THE SCLEROTIC.

PENETRATING WOUNDS OF THE CORNEA AND SCLEROTIC.—A small incised wound of either the cornea or sclerotic, provided none of the other textures of the eye are injured, is almost harmless; it rapidly heals, and no further inconvenience is experienced. We have evidence of this in the numerous operations on the eye, and especially in those for cataract and iridectomy. Wounds, however, which are produced by accident, are generally complicated by either contusion, hæmorrhage, prolapse of the iris, laceration of the lens capsule, or loss of vitreous; and sometimes by all these casualties together. The danger

of a corneal wound is immensely increased if it should extend into the ciliary region, as there is then great risk of the other eye becoming affected with sympathetic ophthalmitis.

Perforating wounds in the sclerotic are much more fatal to the eye than similar wounds in the cornea; they are more difficult to heal, and they will occasionally remain patulous, especially if the cut be in the lower region of the eye, and if there has been a loss of vitreous at the time of the accident.

This occasional incapacity to unite is due to the continued gaping of the wound, caused partly by the rigid cup-like sclerotic being unable to adapt itself to the sudden diminution of bulk induced by an escape of vitreous, and partly also by the continued draining of the vitreous through the wound, which tends to keep the cut edges apart by preventing the eye from being again distended by an abundant secretion of aqueous. If, however, the wound in the sclerotic be closed by a fine suture, and the escape of vitreous be thus arrested, union will at once take place.

The suture should be of the finest silk, to each end of which a small needle should be fastened, so as to allow of the silk being drawn through each edge of the wound separately, and from *within* outwards.

General Treatment.—The primary treatment must be soothing; the patient should be kept in a subdued light, and the injured eye should be closed, and a compress bandage applied over the lids. Two or three leeches should be applied to the temple, thus anticipating rather than waiting for any excessive action which may arise, and one or two drops of a solution of atropine (F. 10) should be dropped into the eye twice a day, each time the compress is readjusted. After a few days the compressing bandage may be discontinued, and warm or cold applications to the eye may be substituted, in accordance with the feelings of the patient. Belladonna may be used either in the form of a cold lotion (F. 41) or a warm fomentation (F. 7), and atropine should be continued until the wound has soundly healed and all irritation has subsided.

The Constitutional Treatment will vary somewhat with the condition of the patient. The inflammation which follows such injuries is reparative in its action, and requires to be watched and kept from exceeding its proper limits rather than that means should be taken to completely check it, as the part may perish from a want of vital action as well as from an excess of energy.

If the patient is robust, a brisk purgative may be prescribed, with some saline or diaphoretic medicine. A regular antiphlogistic course is seldom if ever required. A moderate, well-regulated diet, the avoidance of more stimulants than the case demands, and rest both to

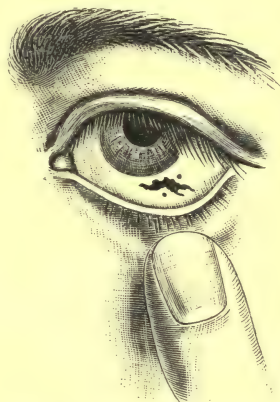


FIG. 102.—Gaping wound of the sclerotic, which was successfully treated by a fine suture.

the eyes and body, place the patient in the condition most favourable for recovery. Pain in the eye sufficient to prevent sleep should be relieved by opiates, taking care at the same time that there is a regular daily action of the bowels.

In delicate and feeble patients it may be necessary to order from the very commencement a liberal diet and a certain amount of stimulants, and to prescribe tonics, such as the mineral acids, with cinchona, or quinine, combining a few minims of Liq. Opii with each dose, to allay the constant irritability which injuries to the cornea often excite in such patients; or the opiate may be given in one full dose at bedtime.

For wounds of the cornea complicated with prolapse of the iris, or wound of the lens, *see* Articles "Prolapse of the Iris" and "Traumatic Cataract."

RUPTURE OF THE SCLEROTIC, OR RUPTURED GLOBE.—This is the most severe injury that can happen to the eye. It either destroys the eye at once, or else so impairs it that it seldom sufficiently recovers to be of much service. It is usually caused by blows on the eye with the fist, or with some blunt or semi-blunt instrument, or by the patient falling and striking his eye against some projecting object. The exact spot at which the eye will burst depends partly on the situation of the point which receives the force of the blow; still the locality in which the rupture takes place is so frequently the same that the coincidence must be due to more than mere accidental circumstances.

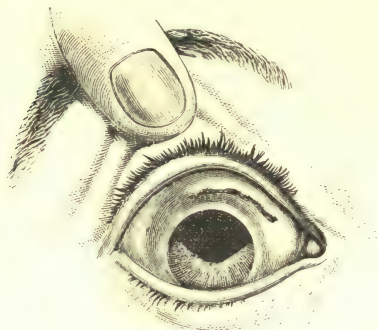


FIG. 103.—Rupture of the sclerotic in the ciliary region.

As in Fig. 101, the upper portion of the iris has been torn away by the lens, which was extruded through the rent at the time of injury.

The split in the sclerotic is almost invariably near the margin of the cornea, following somewhat the direction of its curvature, about one sixteenth to one eighth of an inch distant from it, and immediately anterior to the insertion of the recti muscles. The rent most commonly occurs in the horizontal diameter and upper region of the eye, in a line extending inwards from between the margin of the cornea and the superior rectus, as shown in Fig. 103. The next most frequent site is towards the inner side, between the cornea and the internal rectus. It is comparatively seldom that it occurs to the lower or outer side of the cornea. If the rent be either to the inner or the outer side of the cornea, the split is more or less vertical, thus following the curve of the cornea.

The cornea itself may be, and is frequently, ruptured by blows on the eye; but the injury, when confined to the cornea, is usually less severe, and the result less disastrous, than when the rent is through the sclerotic. A blow, to rupture the sclerotic, must be direct, or nearly so,

and inflicted with great force; whereas a side or glancing one will split the cornea.

In rupture of the sclerotic the injury is unfortunately not only confined to the laceration of this coat. The force which is required to produce it is so great that all the tissues within the eye suffer more or less. A portion of the iris is often prolapsed through the wound, and in some cases the greater part, or even the whole of the iris, is detached and shot out with the lens. The lens is usually dislocated; most frequently it is jerked out through the wound, and escapes unnoticed.

There is generally free hæmorrhage from the different structures of the eye involved in the injury. From the torn iris and ciliary processes blood is usually effused into the anterior chamber and into the vitreous; and from the ruptured choroidal vessels blood-clots are formed between the choroid and retina, and frequently also between the choroid and sclerotic. Vitreous humour may escape from the wound at the time of the accident, and occasionally in a sufficient quantity to cause a partial collapse of the globe.

Prognosis.—Our prognosis in cases of rupture of the eye must always be very unfavourable; the wound is a contused and lacerated one—the most unfavourable for primary union,—and it is in the ciliary region—the most dangerous part of the eye for the infliction of injuries.

There are, however, cases in which a certain amount of sight is regained after an accident of this kind; and we have known instances in which the eye has so far recovered as to be able with a lens to read large type (Jaeger 20).

Treatment.—When the patient is seen shortly after the accident which has ruptured the sclerotic, it is often difficult to ascertain the exact amount of damage the eye has sustained, as the anterior chamber is usually filled with blood, and the different parts of the eye thus masked from observation. In such cases it is well to watch the patient and to wait a few days before deciding on the ultimate course to be adopted. Two or three leeches should be applied to the temple of the injured side, and repeated in twelve or twenty-four hours if the eye is very painful. Soothing applications afford the greatest relief, and a double fold of linen wet with the belladonna or the opium lotion (F. F. 41, 48) may be laid over the closed lids. If the eye progresses favourably, towards the end of the week the blood in the anterior chamber will have been sufficiently absorbed to allow of a more accurate examination being made. The patient, though unable to discern objects, ought now to have a fair perception of light; failing to possess this, a very unfavourable prognosis must be formed.

If, after a fair trial of treatment, the eye is found to be irreparably destroyed for all purposes of vision, our own feeling is that it is by far the safest and wisest plan to remove it; a long period of certain anxiety will be thus saved, all further suffering will be ended, and the safety of the other eye will be secured.

There are, however, certain cases of rupture of the globe in which the injury has been so extensive that the eye has been manifestly destroyed at the time of the accident. A severe rent in the sclerotic or cornea, with extrusion of the lens and a portion of the iris and

choroid, perhaps attended with a collapsed or softened state of the globe from a loss of vitreous, would render any attempt to preserve the eye not only futile but inadvisable. After such an injury, the only proper treatment is to at once excise the globe.

TUMOURS OF THE SCLEROTIC.

The sclerotic is frequently invaded by extension of growth from neighbouring structures, such as the cornea or any part of the uveal tract. On account of its great density and slight vascularity, it offers considerable resistance to the progress of neoplasms, and for the same reason it is very rarely the primary seat of a new growth.

CHAPTER XIII.

THE PUPIL.

I. THE NORMAL PUPIL.

THE fibres for the contraction and dilatation of the pupil are contained in the ciliary nerves derived from the lenticular ganglion. They consist of fibres from the third nerve, which supply the sphincter of the iris and control contraction, and of sympathetic fibres, which preside over the dilatation of the pupil. The latter originate in the cilio-spinal centre, situated in the medulla, and thence pass down the cord to the level of the second dorsal nerve, whence, leaving by the communicating branch to join the cervical sympathetic chain, they reach the eye by the cavernous plexus and lenticular ganglion. The contraction of the pupil is undoubtedly a muscular act, but what the exact nature of the dilatation of the pupil may be is still, as it has been for many years, a matter of controversy. If the layer of radial fibres described in the anatomy of the iris, which lie beneath the posterior epithelial lining of the iris, are muscular in nature, and it is most generally admitted that they are, then the dilatation of the pupil is, in part at any rate, the result of an active muscular contraction. On the other hand, there are many who maintain that these radial fibres are altogether elastic in nature, and that the function of the sympathetic fibres is to inhibit the action of the sphincter, the resulting dilatation being caused by the inherent elasticity of the iris aided possibly by a synchronous vaso-constriction. Even admitting that there is a radial zone of unstriped muscular fibres, the stratum is so thin that it seems difficult to believe that it is alone responsible for dilatation of the pupil. Moreover, whilst in some instances, such as in the further dilatation that follows the instillation of atropine into an eye, the pupil of which is already dilated from paralysis of the third nerve, the phenomenon is best explained on the assumption of an active muscular contraction; yet in other cases, such as in the dilatation of the pupil in shaded light, it would seem *à priori* more probable that dilatation is due to a decrease or relaxation of a previously existing contraction.

For inasmuch as the dilatation increases proportionately with the cutting off of the light, it would otherwise be necessary to assume that a constantly decreasing stimulus can evoke a constantly increasing reflex contraction, which is a *reductio ad absurdum*. On the whole the evidence is strongly in favour of the existence of a layer of muscular fibres and of an active muscular dilatation of the pupil. Under what circumstances and to what extent this active dilatation works alone, or combined with an inhibition of the sphincter iridis, is uncertain, but in many cases such an inhibition is certainly one and sometimes the chief factor in the production of the dilatation.

Like all other sphincters, that of the iris maintains a tonic contraction when at rest, and this is exemplified by the contraction of the pupils which is always present in sleep or in the early stages of anæsthesia.

What may be termed the normal or mean size of the pupils varies very much in different individuals within the limits of health; delicate and nervous children in particular having generally very large pupils, whilst in elderly subjects the pupils are always small. In health both pupils are almost always of equal size, whilst in their movements, which are always involuntary and reflex, both pupils should act equally and synchronously.

Reflex Movements.—The pupil-reflexes are three in number.

1. Light reflex. 2. Reflex on associated movements of the eyes.
3. Reflex to sensory stimuli.

1. Light Reflex.—There are two distinct reflexes. *a.* The direct light reflex. *b.* The indirect or consensual light reflex.

a. The direct light reflex consists in the alterations that take place in the size of the pupil when, one eye being screened, the other is exposed to varying shades of light. An increase in the amount of light is at once followed by a contraction of the pupil and a decrease by dilatation. The experiment may be made by alternately shading and exposing the eye to ordinary daylight, using the hand as a screen; or by exposing the eye to the glare of an artificial light which may be turned off or on as required. The response of the pupil both as regards (1) the range of movement and (2) its rapidity should be noted. A healthy, active pupil will also be seen to oscillate a few times after a fresh contraction before finally assuming its new position.

b. The indirect or consensual reflex of the pupil is the alteration that takes place in the pupil of one eye whilst the other is being tested for its response to direct light stimulation. The consensual reflex in health is equal to and synchronous with the direct reflex.

Note 1.—Each optic nerve contains the afferent fibres (pupillary reflex fibres) for the light reflex contraction. They pass from each optic tract to the third nerve-nucleus of the same side (see “Anatomy of the Optic Tract”). In the case of the consensual light reflex the stimulus is transmitted from one third nucleus to the other by means of commissural fibres.

2. When an eye is completely blind, the direct light reflex is lost and the pupil is moderately dilated, that is it assumes the position that a seeing eye would have in the dark. At the same time, provided that there is no paralysis of the third nerve, the consensual light reflex is exaggerated and greater than the direct reflex in the sound eye, because the reflex in the blind eye is uncontrolled by the sensation of light.

3. *The light reflexes may be absent though the eye has perception of light.* This may be due to the effect of mydriatics or myotics, to paralysis of the third nerve-fibres, to interference with the cilio-spinal paths or centre, or to mechanical obstruction, such as inflammation or adhesions of the iris to the lens capsule or cornea.

In very rare cases the light reflex may be present in a blind eye in disease of the cortical visual centres, where the lesion is situated above the junction of the third nerve-fibres (pupillary reflex fibres) with the optic tract (Fuchs).

2. The Reflex in Associated Movements.—Convergence of the visual axes is always accompanied in health by a contraction both of the ciliary muscles and of the pupils. The reflex is best observed by directing the patient to look first into the distance and then at one of his fingers held within a few inches of his eye. The contraction that follows is equal and synchronous in both eyes, but the range of movement is not so large as that evoked by the action of light. It is dependent rather upon convergence than accommodation, as it is seen in high degrees of myopia when the accommodation is not employed, and whatever be the refraction the amount of contraction is regulated by the extent of the convergence. The reflex is also independent of the light reflex, for it may still be present when the eyes are quite blind, or when the light reflex is absent from other cause, as in *tabes dorsalis* (Argyll-Robertson's pupils).

The reflex seems to be effected by a primary impulse to convergence which is conveyed to a common centre for the contraction of the pupil, for accommodation, and for convergence, which is situated in the region occupied by the nuclei of the third nerves. The object served by the contraction of the pupil in both the associated and light reflexes is the same, *viz.* the cutting off of the peripheral rays and the consequent sharpening of the image.

3. Reflex to Sensory Stimuli.—Sudden pricking or tickling of the skin in various parts of the body is accompanied by a reflex dilatation of the pupils analogous to other superficial reflexes.

II. ABNORMAL CONDITIONS OF THE PUPILS.

These consist in abnormal dilatation or "*mydriasis*," or in abnormal contraction or "*myosis*," affecting one or both pupils.

Mydriasis.—The causes, which are intra-ocular and extra-ocular, may act either through paralysing the sphincter muscle by direct injury of

the muscle or the nerve-filaments supplying it, or through stimulation of the cervical sympathetic.

The *intra-ocular changes which may produce mydriasis are*—

1. Increased or glaucomatous tension of the globe, by paralyzing the ciliary nerves.
2. Diseases of the choroid and retina, by lessening the sensibility to light.
3. Injuries involving the ciliary nerves either by laceration or by pressure, as from a blood-clot or dislocated lens.
4. Laceration or splitting of the fibres of the sphincter muscle by contusions or wounds.
5. The local application of certain drugs known as "*mydriatics*."

The *extra-ocular changes causing mydriasis may be grouped as follows* :

1. Paralysis of the third nerve either from pressure by blood-clot, cerebral tumour, or other form of destructive cerebral disease, or from exposure to cold, diabetes, syphilis, diphtheria, etc.
2. Disease or pressure involving the optic tract or optic nerve.
3. Irritation of the cervical sympathetic.
4. Nervous depression and shock. Thus the pupils are dilated in exhausting diseases, such as phthisis, or in continued fevers, such as typhoid, or after excessive muscular exertion and fatigue, or from malnutrition, from defective or ill-aerated blood, as in anæmia, cardiac insufficiency, or dyspnœa. Similarly, dilatation of the pupils is seen in extreme collapse or in the most advanced stages of chloroform narcosis, or in cases of sudden fright, as the result of severe nervous depression. It may be remarked that the dilatation of the pupils in all these instances is analogous to the general relaxation of the other sphincters of the body which we observe under similar conditions.

It is sometimes very difficult to ascertain the cause of mydriasis. It may occur suddenly in one eye, without any other paralytic symptoms, and only cause a slight impairment of vision without any loss of accommodation. In this condition an eye may remain for many months, or even years, the pupil continuing fixedly dilated a third or a half more than that of the other eye, without any further evidence of disease being manifested. In such cases eserine will induce a full contraction of the pupil, and it is probable that there is no absolute paralysis of the filaments of the third nerve which supply the iris; but simply a preponderance of power in the radiating over the sphincter fibres, possibly due to some reflex irritation.

In other cases of mydriasis there is usually diminution, and sometimes complete loss, of the accommodative power of the eye. To ascertain if the impairment of vision be due solely to the dilated pupil, it is only necessary to try the effect of making the patient look with the affected eye through a pinhole aperture in a piece of card held close to the eye, when, if there be no loss of accommodation and the retina be sound, the acuteness of vision will be restored.

Mydriatics.—Of the drugs which exercise a dilating influence on

the pupil, the most prominent are sulphate of atropine, sulphate of duboisine, hyoscyamine, hydrobromide of hyoscine, sulphate of daturine, and hydrobromate of homatropine.

The *sulphate of atropine* prepared from belladonna is the most efficient of all the mydriatics we at present possess. Its effects are produced by the solution of atropine permeating the cornea and coming into direct contact with the nerves of the iris. This has been proved by tapping the anterior chamber of an eye under the influence of atropine, and, with the aqueous, dilating the pupil of another eye. Its action is chiefly, if not entirely, due to its paralysing the filaments of the third nerve which go to the iris and ciliary muscle, thus producing complete relaxation of the sphincter pupillæ and paralysis of accommodation. From Ruete's observations it would appear that atropine also stimulates the radiating or dilating fibres of the iris to contract, as he found that the widely dilated pupil which accompanies complete paralysis of the third nerve would expand further under the influence of atropine. In practice the sulphate of atropine is preferred to the alkaloid, on account of its greater solubility.

It may be used in the form of drops of a strength of grs. i to grs. iv ad ʒj, according to the effect required, or combined in an ointment or lotion (see "Formulary").

Toxic Effects of Atropine.—The drug should always be used with discretion, and it is necessary to draw attention to this point, because its great value in ophthalmic surgery has led in many cases to its indiscriminate use as a cloak for ignorance, and not infrequently to subsequent disastrous consequences to the eye. In the first place its action is extremely powerful, and the instillation of one or two drops of a solution of grs. iv ad ʒj will paralyse the accommodation for several days, causing great inconvenience if unnecessarily applied, on account of the inability to read and work thereby produced. In the second place, some patients are, from some idiosyncrasy, very intolerant of atropine, and this peculiarity may show itself either by their exhibiting symptoms of general poisoning from the drug, such as violent delirium, etc.; or by an acute local inflammation known as "*Atropine Irritation*." In the latter case there is an acute erysipelatous inflammation of the lids, accompanied by much photophobia and lacrymation from a consecutive follicular inflammation of the conjunctiva. A hypodermic injection of morphia is the best antidote if symptoms of general poisoning have set in, whilst the local inflammation will soon subside if the drug is discontinued. Thirdly, in patients over middle age especial caution is needed in the use of atropine, on account of the increasing shallowness of the anterior chamber, and the danger of provoking a glaucomatous attack. It has been suggested that the presence of some free acid is the reason of the sulphate of atropine acting occasionally as an irritant; but this theory is untenable, as the drug is a neutral salt.

Duboisine, Daturine, Hyoscyamine, and Hyoscine, known also as *Scopolamine*, are chiefly employed as substitutes for atropine when that drug causes toxic symptoms (see "Formulary"). They are closely allied to atropine, and, speaking broadly, act in a precisely similar way.

Duboisine and hyosine are perhaps the best alternatives to atropine, and both are very powerful mydriatics, especially the latter. They, however, occasionally give rise to toxic symptoms, and some caution must therefore be employed when trying them for the first time.

Homatropine is a very useful mydriatic. It dilates the pupil more quickly than atropine, but is much less energetic and lasting in its action. As it also paralyses the accommodation,—though inferior to atropine in this respect as well,—it is often employed for working out errors of refraction by retinoscopy, especially in adults. It acts most speedily and efficiently when combined with cocaine (F. 20), and its effects wear off in thirty-six to forty-eight hours. The general properties of this drug have been well worked out by Ringer and Tweedy.*

Mention must also be made of *Mydrine* and *Euphthalmine*, both of which are useful drugs when a transient dilatation of the pupil is required without seriously impairing the accommodation, as for an ophthalmoscopic examination. Mydrine is usually employed in a 10 per cent. solution, and euphthalmine in one of 2 to 5 per cent., and the mydriasis is of shorter duration than that following the use of homatropine.

Cocaine Hydrochloride has many valuable properties as a mydriatic, for our knowledge of which we are indebted to the experimental investigations carried out by Jessop.† Its action is speedy, transient, and does not abolish the light reflexes nor interfere with accommodation, unless pushed to its highest degree. In the latter case a greater mydriasis can be obtained than with any other drug, which is proved by instilling cocaine into an eye already under the influence of atropine, when further dilatation follows; and conversely by the fact that the application of atropine to an eye already fully under cocaine only abolishes the accommodation without altering the size of the pupil. Dilatation is accompanied by marked vaso-constriction, and depends upon a local stimulation both of the dilating and vaso-constricting fibres of the cervical sympathetic, and not upon an inhibition of the third nerve. Thus, if the cervical sympathetic be divided, the instillation of cocaine has no effect on the pupil; but if eserine be instilled into an eye under the influence of cocaine, a contraction of the pupil is easily and quickly obtained. Conversely if cocaine is instilled into an eye, the pupil of which is already dilated by paralysis of the third nerve, a further dilatation follows.

Advantage of these properties may be taken clinically in several ways.

1. It is sometimes an useful adjunct to atropine when a maximum mydriasis is required (F. 11).
2. When employed with homatropine, the latter drug acts more quickly and efficiently (*see* "*Homatropine*").
3. With eserine it often acts beneficially, owing to its vaso-constricting property, and by abolishing the pain that eserine often

* 'Lancet,' May 22nd, 1880.

† 'Proc. of the Royal Soc.,' No. 238, 1885.

produces. The mydriatic tendency of cocaine is no objection, as it is easily overcome by the eserine (F. 17).

4. The rapid, transient, and easily controlled mydriasis of cocaine, with its tendency to lower intra-ocular tension, renders it a very valuable means of securing a sufficiently large pupil for a thorough ophthalmoscopic examination in many cases in which other mydriatics are contra-indicated.

For the uses of cocaine as a local anæsthetic see "Appendix."

Myosis may arise from spasmodic action of the sphincter or from paralytic affections of the pupil-dilating fibres.

The causes are either intra-ocular or extra-ocular.

The *intra-ocular causes which may produce myosis are*—

1. Inflammation of the iris from swelling and congestion of its fibres.
2. Sudden decrease in intra-ocular pressure, producing congestion, as in evacuation of the aqueous.
3. Inflammation and ulceration of the cornea, by causing a reflex spasmodic contraction of the sphincter.
4. Hyperæsthesia of the retina, from exposure to strong lights, etc. This acts reflexly on the pupil, like irritation of the cornea.
5. Habitual overuse of the accommodation by constantly working at minute objects, as in watch-making, etc.
6. The local instillation of certain drugs known as "*myotics*."

The *extra-ocular causes are*—

1. Suspension of the reflexes. This is not always abnormal, as it occurs naturally in sleep; but contraction of the pupils from this cause is observed in the early stages of chloroform and alcohol narcosis, etc.
2. Irritation of the fibres of the third nerve or any part of the pupil-contracting paths, as in inflammatory diseases of the brain, etc.
3. Pressure upon or injury to the cervical sympathetic. Thus contraction of the pupil not infrequently accompanies a tumour in the neck, such as an aneurysm, etc.
4. Disease affecting the cilio-spinal centre in the medulla or the cilio-spinal fibres as they run in the upper part of the cord (spinal myosis). When myosis is due to this cause there is often a great desire for strong lights, due to commencing atrophic changes in the optic nerves.

Myotics.—Of the drugs which exercise the power of contracting the pupil, the most efficient are extract of Calabar bean, sulphate of eserine, and nitrate of pilocarpine.

Calabar Bean—*Physostigmatis faba*.—For the knowledge we possess of the peculiar properties of the Calabar bean, we are indebted to Fraser and Argyll Robertson.

The Calabar bean rapidly induces extreme contraction of the pupil and a myopic state of vision, and this it does by stimulating the

branches of the third nerve, and producing a temporary spasm of the sphincter pupillæ and ciliary muscle. In from five to ten minutes after the application of the drug the pupil begins to contract, and in from half to three quarters of an hour it has reached its maximum effect. The pupil is then reduced to rather less than a line in diameter, and the eye is rendered myopic, the near and far points being approximated to the eye. These changes last for a variable time in accordance with the strength of the solution which has been used. The accommodative power is often restored in a few hours, whilst it will frequently take two or three days before the pupil will regain its normal size. The bean also possesses the power of counteracting for a time the influence of atropine. Thus, if a little of a *strong* solution is introduced into the eye whilst the pupil is dilated to its utmost with atropine, it will generally cause it to contract to its natural size, and sometimes even smaller, if the dilatation of the pupil is due to a *weak* solution of atropine. This effect, however, of the bean is evanescent, and passes off in a few hours, as the atropine resumes its sway over the pupil.

The best preparations of the Calabar bean are its extract (F. 22) and the sulphate of eserine.

Sulphate of Eserine, prepared from the Calabar bean, is the most efficient myotic we possess. The solution (F. 16), when made with the freshly prepared sulphate, is of a light dirty-greenish colour, but it rapidly changes to a dark red. This decomposition does not affect its activity.

Nitrate of Pilocarpine is obtained from Jaborandi (the leaves of a species of *Pilocarpus*). It is an efficient myotic, but is less active than eserine (F. 23).

All the myotics have a tendency to reduce excess of tension of the globe. They are very valuable in cases of incipient glaucoma, and in some of those ulcerations of the cornea which are associated with increased tension.

For the indications, dosage, etc., of eserine and pilocarpine in glaucoma *see* page 245.

Hippus.—This is a term given to a rare condition in which the pupils exhibit constant purposeless oscillations, occurring independently of the ordinary reflex stimuli of light and convergence. It is often associated with nystagmus, and may occur as a local symptom in disseminated sclerosis and some other forms of nerve disease. We have recently seen a case of early disseminated sclerosis associated with optic atrophy and nystagmus, in which one eye only was affected with well-marked hippus. On the other hand, these oscillations may sometimes be noted in perfectly healthy eyes, and one is sometimes confronted with the question as to whether one is dealing with pupils that are simply hypersensitive to gradations of light, or a true neurosis, by which we mean a pathological disturbance of the normal reflex.

CHAPTER XIV.

DISEASES OF THE IRIS AND CILIARY BODY.

Anatomy.—The **Ciliary Body** (Fig. 104) forms the anterior continuation of the choroid. It commences at the line of the ora serrata (see “Retina”), and in section is seen to form a triangular eminence with its base or short side looking forwards. It consists of an internal part, the continuation of the choroid proper, which is deeply pigmented and consists of a series of radiating folds—the *ciliary processes*,—and an external or deeper non-pigmented part, which is made up of unstriated muscle-fibres, and is known as the *ciliary muscle*.

The ciliary processes, about seventy in number, radiate towards the lens, forming a complete circle about its equator, but separated from it by a narrow space—the *circumlental space*,—which is bridged over by the fibres of the *suspensory ligament of the lens*. The ciliary processes are covered by the hexagonal pigment-cells of the retina proper, surmounted internally by a stratum of cylindrical non-pigmented cells; and the two form the *pars ciliaris retinae*, or anterior continuation of the retina beyond the ora serrata. The ciliary processes are responsible for the secretion of the nutritional fluid of the eye, which is effected by numerous involutions or downgrowths of the epithelium in the form of simple glands known as the *ciliary glands* (Collins), and, owing to the numerous plications of the processes, a large area of secreting surface is provided.

The fibres of the *ciliary muscle* are disposed in two layers, one set running meridionally from an origin about the sclero-corneal junction to be inserted into the anterior portion of the choroid, and a more internal set of circular fibres lying immediately beneath the ciliary processes. (For the action of the ciliary muscle see “Accommodation.”)

The **Iris** arises from the base or anterior surface of the ciliary body. It is a contractile diaphragm spreading across the space between the cornea and lens, and dividing it into anterior and posterior chambers, which are filled by the aqueous fluid, and communicate with each other by a central aperture in the iris diaphragm, known as the *pupil*. The iris is placed immediately in front of the lens, and its pupillary margin

lies in actual contact with the lens capsule, so that the anterior chamber is very much the larger of the two, and the posterior chamber is represented by the shallow space that exists between the extra-pupillary portion of the iris and the sloping peripheral surface of the lens.

The iris consists of a vascular and pigmented stroma of connective tissue, which contains two sets of specialised fibres. It is covered anteriorly by a continuation of the epithelial cells lining Descemet's membrane on the posterior aspect of the cornea; whilst the pigmented epithelial lining of the ciliary processes (*pars ciliaris retinae*) is continued over its posterior surface as far as the margin of the pupil. One set of special fibres is disposed concentrically round the pupil, and consists of a layer of unstripped muscle tissue forming a sphincter

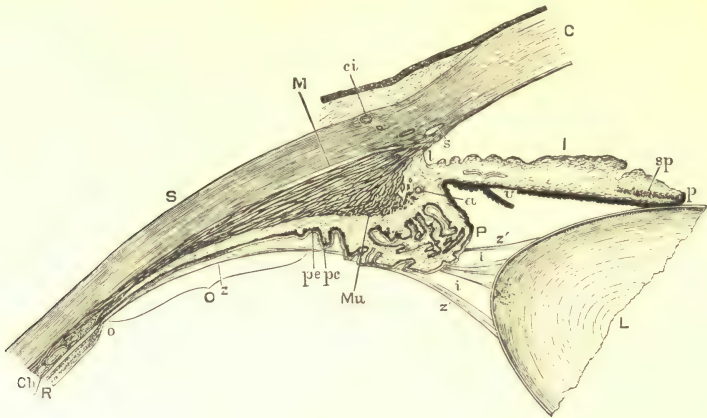


FIG. 104.—The ciliary region of the eye. (After Fuchs.)

(S) Sclerotic. (C) Cornea. (L) Lens. (R) Retina. (Ch) Choroid. (I) Iris. (P) Ciliary processes. (M) Longitudinal fibres of the ciliary muscle. (Mu) Circular fibres of the ciliary muscles. (l) Ligamentum pectinatum. (s) Canal of Schlemm. (a) Circulus iridis major. (sp) Sphincter pupillae. (v) Uveal pigment lining the iris and turning forwards at the pupillary border (p). (ci) Anterior ciliary vessels. (O) The flat portion of the ciliary body extending to (o), the ora serrata, and giving attachment to (z z'), the zonule of Zinn, which encloses (i), the canal of Petit. (pe, pc) Layers forming the *pars ciliaris retinae*.

whilst the other set consists of a stratum of elastic radial fibres, which is separated posteriorly from the pigment lining by a delicate radial layer of unstripped muscle-cells. This latter set forms the dilating apparatus of the iris; though the presence of muscle-cells in the radial zone is denied by some.

The iris is of unequal bulk, being thickest at its periphery, where it forms a broad attachment or *root* to the ciliary body, and is here separated from the cornea by a rounded space known as the "*angle of the anterior chamber*." This space is bridged by a loose-meshed stratum of connective tissue, known as the "*ligamentum pectinatum*," the meshes of which form a series of channels, called the "*spaces of Fontana*." The latter serve for the percolation of the aqueous fluid, which passes from

them into a venous channel or sinus called the "*canal of Schlemm*," which occupies the extreme angle between the cornea, ciliary body, and iris (see Fig. 104).

The colour of the iris depends upon the number and density of the stromal pigment-cells, which are in direct proportion to the depth of colour, and to them also is due the peculiar and characteristic lustre reflected from a healthy iris.

The arterial supply of the ciliary body and iris is furnished by the ciliary arteries, some of which run forward between the sclerotic and choroid; whilst others, the anterior ciliary arteries, pierce the sclerotic close to the corneal margin. To congestion of the latter is due the characteristic pink zone which surrounds the cornea in inflammation of the iris and ciliary body, and is known as "*ciliary congestion*." Upon the iris the arteries form two arterial circles, the one (*circulus iridis major*) round the periphery, and the other (*circulus iridis minor*) round the pupil; the two vascular rings being connected by numerous intercommunicating twigs.

The ciliary body and the sphincter muscle of the iris are supplied by the ciliary nerves from the lenticular ganglion, which contain motor fibres derived from the third nerve by means of its motor root to the ganglion. The sympathetic has also some action upon the pupil. Stimulation of the cervical sympathetic is followed by dilatation, and its section by abnormal contraction of the pupil (see also "Pupil," page 187).

The Aqueous Humour is a clear limpid fluid containing about 98 per cent. of water with a small trace of albumen. It fills the anterior and posterior chambers, and is secreted by the ciliary glands (*vide supra*). Its function seems to be twofold. It serves in the first place as a medium in which the iris can freely act, and secondly, by virtue of the albumen it contains, it probably aids in the nourishment of the avascular lens and cornea, forming the anterior collection of the great nutritional fluid of the eye which is constantly circulating through the globe, and which is of so great importance in the history of glaucoma. The fluid is constantly and slowly secreted according to requirements; but the rate of secretion can be very rapid, as may be seen after perforating wounds of the cornea, when the anterior chamber, if the wound is occluded, may be re-formed within a few minutes. The fluid secreted under these circumstances, however, is largely serous in nature, and contains much albumen. It is, doubtless, in great measure effected by exudation from the ciliary veins, which follows the sudden decrease of intra-ocular pressure after perforation.

CONGENITAL ABNORMALITIES.

COLOBOMA OF THE IRIS is a congenital deficiency of a portion of the iris caused by non-closure of the anterior portion of the fœtal cleft. The deficiency, therefore, usually occurs in the lower median line (see Fig. 105), and it may be associated with a similar defect in the choroid or optic nerve-sheath.

It sometimes shows a family predisposition, as in a case related by the late Mr. White Cooper in which three out of a family of seven children were affected with microphthalmos and colobomata of both



FIG. 105.—Coloboma of the iris.

irides. We have also recently seen twin children, both of whom had a coloboma of the left iris associated with high myopia in that eye, whilst the right eye in each case was emmetropic, and the iris normal.

IRIDEREMIA—Aniridia—Absence of the Iris.—Occasionally the iris is entirely absent or represented by a rudimentary stump attached to the ciliary processes. The aqueous humour in these cases is always secreted normally, showing that the iris does not share in the secreting process, as was formerly supposed.

IRIDO-DONESIS—Tremulous Iris—are terms applied to an iris which trembles and vibrates with each movement of the eye. It is produced by loss of the support afforded by the lens, and so may either occur as a congenital abnormality in cases of congenital dislocation of the lens and congenital hydrophthalmos, or in later life as a symptom of dislocation of the lens or of its loss from operation or injury.

VARIATIONS IN COLOUR.—The depth of colour of the iris is in proportion to the density and amount of its stromal pigment. In albinos, where there is a general lack of pigment both in the stroma and uveal lining, the iris is greyish white and translucent, admitting the red reflex from the fundus to shine through and give the eye a pink hue. It not infrequently happens that one iris is of a different shade to the other, or there may be variations of colour in different portions of the iris.

Variations in colour may also be due to pathological causes as the result of inflammation or atrophy. In eyes long lost from disease the iris is frequently of a pronounced greenish tinge.

CAPSULO-PUPILLARY MEMBRANE.—In most cases the vascular membrane, which in foetal life stretches across the anterior face of the lens, entirely disappears about two months before birth (see "Development"); but occasionally fragments of it persist as greyish tags binding the pupil down in this situation to the capsule of the lens. They are often mistaken for inflammatory adhesions; but their true nature can be ascertained by noting that the tags spring from the surface of the iris, and not from the pupillary edge, as do adhesions of an inflammatory nature. Their greyish-white colour is in sharp contrast

with the brown hue of synechiæ, and they are also, as a rule, distinctly triangular in shape, with a broad base springing from the iris, and a point of attachment to the capsule.

CORECTOPIA, or *displacement of the pupil*, is generally seen in association with congenital displacement of the lens. The same cause that produces the displacement of the lens, namely, mal-development of the ciliary processes and suspensory ligament, causes a corresponding displacement of the iris; the pupil with the lens being drawn away by the unbalanced traction exerted on the side opposite to the defect.

POLYCORIA, or *multiple pupils*, is an occasional anomaly. The pupil may be divided by a tag of capsulo-pupillary membrane, or a coloboma of the iris may be bridged in a similar manner. A few cases have also been recorded in which there were actual gaps in the iris tissue.

DISCORIA, or *alterations in the shape of the pupils*.—The pupil is not infrequently oval instead of circular, the long diameter being placed either vertically or horizontally. Sometimes the alteration in shape may be due to the traction of a fragment of capsulo-pupillary membrane, whilst in other cases it is associated with “corectopia,” and in others, again, there is no satisfactory explanation of the condition.

ANISOCORIA, or *inequality of the pupils*, is nearly always a pathological condition, but it may occasionally occur as a congenital anomaly for which no satisfactory explanation can be offered.

INFLAMMATION OF THE IRIS—IRITIS.

Iritis may be a *primary disease*, or it may be *secondary* to an inflammation of one or other of the coats of the eye.

Primary Iritis may arise—1. From some constitutional taint, as syphilis, rheumatism, gonorrhœa, or gout. 2. From sudden exposure to cold. 3. From an injury to the eye, which may be either mechanical or chemical, and to this form the term *traumatic* is applied. 4. As a complication of many exhausting diseases, especially pneumonia, typhoid, and influenza.

Secondary Iritis is caused by the extension of an inflammation from one of the tissues of the eye with which the iris is connected.

Iritis may be either acute or chronic; but in either case its symptoms and progress are modified by the cause which produced it.

In the more acute degrees of inflammation it is very common for the ciliary body to become involved, forming an irido-cyclitis, the onset of which is marked by special symptoms.

General Symptoms of Iritis.—The aqueous becomes yellow and serous, and, as the disease advances, it frequently grows turbid from flocculi of lymph or pus, which will sometimes sink to the bottom of the anterior chamber, forming hypopyon.

The iris loses its striated appearance from lymph effused on its

surface and into its texture; its colour becomes consequently changed, and its brilliancy is dulled. A blue or a grey iris assumes a greenish hue, and the darker irides grow of a rusty or brownish red. The change of colour of the iris at the commencement of the attack is often more apparent than real, and is due to the iris being seen through a yellow serous aqueous, which imparts to a blue or a grey iris a greenish tinge. In the more advanced stages the altered colour and loss of striation are dependent on fibrinous effusion.

The pupil is contracted and sluggish in its action from congestion of the iris tissue, and the pupillary margin soon contracts adhesions to the capsule of the lens (*posterior synechiæ*). At first the adhesions are few and weak, giving an irregular outline to the pupil, and often at this stage yielding under the influence of atropine. But if the disease be unarrested by treatment, the whole pupillary margin becomes sealed to the lens capsule, forming what is termed *complete ring synechia*; and so firm is the bond of adhesion that atropine will frequently fail to dilate any portion of the pupil. The disease still progressing, lymph is effused on the capsule of the lens within the pupillary space (*see also* p. 210).

The Vascularity of the Eye in Iritis.—The conjunctival surface is generally suffused, and in some cases there is great redness with slight œdema; but the chief seat of the increased vascularity is in the ciliary vessels, which are seen as a red zone around the cornea. This vascular ring is one of the early symptoms of iritis, and one of the most constant.

In severe cases the increased vascularity of the iris is so great that distended varicose vessels may be often seen with the unaided eye coursing along the surface of the iris.

The impairment of vision is always considerable, and it increases as the disease advances. It is due to the following causes:—The turbid aqueous, the lymph on the capsule of the lens in the pupillary area, and frequently also to the impaired power of accommodation caused by an extension of the inflammation to the ciliary body.

The degree of pain in iritis is very variable; in some cases it is slight, whilst in others it is most acute, and forms one of the prominent symptoms. The pain is of a neuralgic character—in the eye, around the brow, extending upwards over the side of the head, and downwards along one side of the nose. In syphilitic iritis the pain is usually slight, whilst in the rheumatic form it is often very intense.

The involvement of the ciliary body is shown by marked tenderness on palpating the ciliary region, whilst the pain in these cases is always most acute, and the vitreous may become hazy through serous exudation.

Intolerance of light is not, as a rule, a marked symptom in iritis. There is generally some photophobia, but it is seldom that it amounts to the intense dread of light which is witnessed in some of the affections of the cornea. To this, however, there are occasional exceptions, especially in iritis due to rheumatism or injury.

In iritis there is a strong tendency towards recurrence. An eye which has once suffered is rendered specially liable to another attack, and this is peculiarly the case in the rheumatic form of the disease. So

frequent, indeed, are the recurrences of this variety of iritis, that by some it is designated by the special name of *recurrent iritis*.

The General Treatment of Iritis.—The special lines of treatment indicated for the varying types of iritis will be found discussed in their several sections. Only the general treatment that is applicable to all forms of iritis of any origin will be mentioned at this stage.

Local Treatment.—*Atropine.*—Recognising the special dangers that attend the closure of the pupil (*see* page 210), too much attention cannot be paid towards securing the fullest possible dilatation at the earliest moment. Moreover the dilatation of the pupil acts most favourably upon the inflammation by relieving the congestion and pain, and by placing the eye in a state of rest. Of all mydriatics, atropine has proved the most useful, and it should invariably be ordered at the very commencement of an attack, and persevered in during its continuance. It should be prescribed either as an ointment (F. 57) to be placed within the lids, or as drops of the strength of grs. ij to grs. iv ad aquæ ʒj three or four times a day, according to the effect produced. If, as sometimes happens, the use of atropine is not tolerated (*see* page 191), its place must at once be taken by one of the other alternative mydriatics mentioned.

Heat.—The application of heat is very beneficial, and gives great ease in the acute stages. The eye may be bathed frequently for a few minutes at a time by dipping a cupped sponge into some hot soothing lotion, such as the Fetus Belladonnæ (F. 7) or the Fetus Papaveris (F. 8), and applying it to the closed lids, whilst in the intervals it may be fomented by a light compress of absorbent wool, wet with the lotion, and surmounted by a piece of protective silk and a light roll of bandage.

Bleeding.—The local abstraction of blood by leeches or the Heurte-loup is followed in many cases by great relief of pain and subsidence of the inflammation. It is, however, only suited for the young and vigorous, and is especially indicated when the inflammation is very acute and persistent. Two or three leeches may be applied to the temple, close to the orbital margin, and the application repeated according to the surgeon's discretion.

Protection from Light.—In the acute stages the patient should remain in a darkened room, with the eye covered by a wet compress. As the inflammation subsides, protecting goggles of a dark neutral tint should be substituted, and these should be worn until all traces of inflammation have subsided for some time.

Medicinal treatment, apart from the special drugs indicated by the type of iritis, needs but a few words. The bowels must be kept acting regularly, and it is a good plan to commence treatment with a thorough aperient. The diet in the acute stages should be light and non-stimulating, and pain may require for a few days the use of morphia or opium in addition to local treatment. If there is fever with the pain, a dose of Dover's powder at night will be found very useful.

For the treatment of recurrent iritis by iridectomy, etc., *see* page 221.

The following are the chief varieties of primary iritis :

(1) *Syphilitic iritis* ; (2) *Rheumatic iritis, including iritis the result of gonorrhæa* ; (3) *Suppurative iritis* ; (4) *Traumatic iritis*.

SYPHILITIC IRITIS usually first appears during the secondary eruption, or just as it is beginning to fade. It is characterised by a peculiar tendency to the rapid effusion of lymph, which, if not arrested by appropriate treatment, soon leads to permanent damage of the eye. The effusion of lymph is often so copious that nodules of it as large as millet seeds will be seen along the margin of the iris, and sometimes the deposits are in single isolated patches of a greater size. We have seen a third of the iris covered with one solid mass of lymph, and the pupil completely occluded by it ; but we have never known a case of syphilitic iritis go on to suppuration. The pain and dread of light are not usually marked symptoms, and certainly are not so severe as is commonly found in the rheumatic form of the disease.

Treatment.—Mercury is here imperatively called for. It should be given in doses sufficiently large and frequent to bring the patient quickly under its influence, but as soon as the gums begin to grow tender and spongy, the quantity should be diminished so as to avoid anything like profuse salivation. A piece the size of a nut of the unguent. hydrarg. may be rubbed into the axilla night and morning, or a pill with calomel and opium may be given twice a day. If the patient is feeble, quinine may be prescribed at the same time, and this may be conveniently ordered in a pill or mixture during the day, whilst the mercurial inunction is used night and morning. If the patient has already been salivated before he first comes under treatment, an iodide of potassium mixture should be given, and a slight mercurial action may be kept up by rubbing a little of the unguent. hydrarg. combined with belladonna into the brow and temple, and allowing it to remain on during the day ; or, if the patient can bear it, pil. hydrarg. subchlorid. comp. gr. v may be ordered every other night. Pain and restlessness should be relieved by repeated doses of opium. Half a grain of the extract of opium may be ordered every four or six hours as required. It often seems to exercise a marked beneficial influence in controlling the inflammation. When all the effused lymph has been absorbed, and the iritis has nearly subsided, the mercurial medicines should be omitted, but the iodide of potassium should be continued for two or three months, combined with a bitter tonic, or if the patient is anæmic, with some preparation of iron. If the iritis recur after some months, or if it assume a chronic form, a mixture of the perchloride of mercury with the iodide of potassium will be often found of great service.

If, however, the pupil should threaten to become closed by the effusion of lymph on the pupillary area of the lens capsule, and by posterior synechiæ, an iridectomy should be performed when the eye is free from inflammation (*see* page 221).

RHEUMATIC IRITIS is chiefly a serous inflammation ; some lymph is effused, sufficient to cause tags of adhesion between the iris and lens capsule, or even in severe cases to produce a complete closure of the

pupil ; but it is not poured out, as in the syphilitic form, in quantities to be easily seen on the surface of the iris with the naked eye. The aqueous is yellow and serous. The apparent change of colour in the iris in rheumatic iritis is often mainly due to the yellow aqueous through which it is seen. We have frequently noticed the greenish-coloured iris at once restored to its normal grey or blue when the yellow aqueous escaped, either from a puncture in paracentesis of the cornea or in the operation of iridectomy. Rheumatic iritis is often associated with rheumatism elsewhere, such as pains in the limbs or joints ; or the patient has suffered previously from rheumatic fever. In some cases where there are frequent recurrences of iritis, the patient is never completely free from rheumatic pains ; if the limbs and the joints are exempt, the soles of the feet or the heels are tender.

Rheumatic iritis is very recurrent, and although the eye may recover from each attack, yet fresh traces of the disease are each time left, which greatly cripple if they do not eventually destroy the eye. The pain is severe and neuralgic, and sometimes very intense. There is also frequently a great dread of light, which is often quite out of proportion to the severity of the attack.

Gonorrhœal rheumatism is often followed by a serous iritis of a very recurrent nature, and in no way differing from the ordinary rheumatic type of the disease. In one patient who was under our care the recurrence of the iritis was usually preceded by a return of the urethral discharge, which lasted for a few days and then disappeared.

The iritis which sometimes follows exposure to cold and wet is of the rheumatic type ; as is also the inflammation that may occur in the course of exhausting diseases (*see* page 199).

Treatment.—Rheumatic and gouty iritis do not require the active mercurial treatment recommended for the syphilitic form of the disease. When of a definite rheumatic origin, salicylate of sodium is invaluable, and may be ordered in doses of gr. x to gr. xv thrice daily. When this drug is not well borne, iodide of potassium in small doses combined with the bicarbonate of potash or soda may be given during the day, and at night a pill with calomel gr. i, pulv. ipecac. comp. gr. v ; or the unguent. hydrarg. combined with belladonna (F. 63) may be rubbed daily into the temple. In some cases this latter treatment will fail to give any relief, and quinine in 2-grain doses may then be ordered with great benefit ; or the quinine may be combined with the tinct. ferri perchlorid $\text{m} \times \text{ad. } \text{℥j}$. When there is great photophobia and pain in the eye, the quinine, or iron and quinine, treatment, together with a mild mercurial inunction into the temple, will be found most useful. To relieve the pain, the fourth or a third of a grain of the acetate of morphia may be injected subcutaneously into the arm, or half a grain of the extract of opium may be given in a pill every four or six hours. Turpentine has been prescribed with advantage in obstinate cases of *non-syphilitic iritis*. The ol. terebinth. may be ordered in small and repeated doses ; or the chian turpentine may be given in 5-grain doses three times a day. On account of the relapsing nature of the disease, treatment with atropine should be continued for at least a week after all inflammation has apparently disappeared.

If the pupil should become completely closed by adhesions between the pupillary border of the iris and the lens capsule, or frequent relapses occur, an iridectomy should be performed (*see* page 221).

SUPPURATIVE IRITIS is generally consequent on an injury, or it may follow an operation on the eye; but it may also occur without any very apparent cause in patients who are in a low state of health. The disease is characterised by a rapid inflammatory exudation which soon fills the pupil. The iris at first appears hazy, and the markings of it indistinct or lost; its surface then becomes partially or entirely coated with a film of puro-lymph. Particles of lymph and pus gravitate to the bottom of the anterior chamber, and constitute the condition known as hypopyon. Up to this stage the cornea will often continue clear and bright, and if the iritis be now arrested, the eye may recover, but the pupil will be closed by adhesions to the capsule of the lens, and by a false membrane. Unfortunately the disease usually progresses; the cornea next grows steamy and dull; then ulcerates in part; pus is effused between its laminæ, and onyx is formed; perforation will follow, and the eye will probably, for all useful purposes, be lost. (For treatment *see* "TRAUMATIC IRITIS," next section.)

TRAUMATIC IRITIS is due to an injury, generally a penetrating wound, of the eye which has involved either the iris, or the lens, or both. It is most apt to follow when the iris is either contused, lacerated, or partially strangled by prolapse through the wound.

Wounds of the lens are peculiarly apt to cause iritis: the lens swelling from the imbibition of the aqueous presses on the back or uveal surface of the iris, and acts as a most powerful irritant. We have illustrations of this occasionally after needle operations for soft cataract, or after the extraction of hard cataracts, when fragments of cortical matter remain after the lens has been taken away.

Traumatic iritis may occur in two forms—the acute and chronic.

The acute usually comes on within the first four or five days after the injury, and is ushered in with œdema of the lids and chemosis of the conjunctiva. The inflammation may be *plastic*, producing a rapid exudation of lymph into the pupil and on to the surface of the iris, but more frequently it is *suppurative* (*see* preceding section).

Acute traumatic iritis may terminate in three ways:

1. Under suitable treatment the eye may recover; but, as the result of the inflammation, there will probably remain a more or less complete closure of the pupil from a false membrane, with adhesions of the pupillary border of the iris to the lens capsule.

2. The acute symptoms may gradually subside, and the iritis may then become chronic.

3. The eye may be destroyed by an extension of the inflammation to the cornea or to the deeper structures—the choroid and retina.

The chronic form usually commences from one to three weeks after an injury. It is frequently seen after cataract operations, especially if the iris has been much pressed upon in the delivery of the lens, or remains entangled in the wound. It is always accompanied by

photophobia and lacrymation, and the edges of the lids often become puffy, thickened, and excoriated. The aqueous becomes serous, and the striation of the iris indistinct. The pupil is but slightly and irregularly acted on by atropine, and there is a slow, dull pain in the eye. This chronic condition will frequently last many weeks, and it yields but slowly to treatment. Diabetic patients are especially liable to this form of iritis after an extraction of cataract.

Treatment.—In traumatic iritis mercury is seldom required, and in the early stages should not be prescribed. The iritis is due to an injury, and time and rest must be given to allow the eye to recover from the mischief it has sustained. Soothing applications to the eye are beneficial. The solution of atropine (F. 10) should be dropped into the eye two or three times daily, and a fold of linen wet with the belladonna lotion (F. 41) may be laid over the closed lids. If there be much pain, two or three leeches should be applied to the temple, and these may be repeated if necessary. The bowels should be freely acted on by a mild purgative, and if there be much constitutional irritation, an effervescing or saline mixture may be given during the day, and an opiate at night to relieve pain. After the first acute symptoms have passed away, the patient will generally be benefited by the mineral acids with bark. If the iritis should become chronic, a slight mercurial inunction into the temple will sometimes afford relief. If the iritis be *suppurative*, and there is hypopyon, warm applications will afford the greatest comfort, and the Fetus Belladonnæ or Fetus Papaveris may be ordered. When there is hypopyon and great pain, paracentesis of the cornea will often be found very beneficial. After subsidence of the inflammation, the closed pupil must be dealt with by operation (*see page 221*).

Serous Irido-Cyclitis.—See “Catarrhal Cyclitis.”

INFLAMMATION OF THE CILIARY BODY—CYCLITIS.

This may be primary or secondary.

I. CATARRHAL CYCLITIS—SEROUS IRIDO-CYCLITIS.—This disease is characterised by an inflammation commencing in the glands of the ciliary body, and consists in an outpouring or hypersecretion of their normal products, with which are mingled the elements of serous exudation. The inflammation spreads forwards, secondarily involving the iris, and frequently at the same time extending backwards into the choroid as well.

Ætiology.—A large number of patients are the subjects of syphilis, either hereditary or acquired. In another large class, especially composed of women, it follows on great debility and exhaustion from mental anxiety or overwork, or from menstrual disturbances.

Symptoms.—The earliest symptoms are a little ciliary redness at one spot, accompanied by watering of the eyes and increased tension of the globe. The ciliary redness gradually extends, and soon a bluish-red halo partially or completely surrounds the cornea. The anterior

chamber is seen to be abnormally deep, and close examination will reveal some mottling of the cornea, due to the deposit of fibrinous particles upon Descemet's membrane (**keratitis punctata**). These deposits are of two kinds, either of which may appear singly or in combination with the other. Most commonly numbers of minute specks, brown from their origin in the ciliary body, are seen, which in severe cases are scattered over the whole aspect of the cornea; but when less profuse tend to gravitate to the lower quadrant of the cornea, where they collect in the form of a triangle with the base downwards; this peculiar shape being doubtless due to gravity coupled with the centrifugal action caused by rotation of the eyes and head. In the second variety of keratitis punctata, the deposit is collected together into opaque whitish points, easily recognisable with the naked eye. These points are much larger and fewer in number than the brown specks; they bear a remarkable resemblance to colonies of white staphylococci, and are commonly known as "*mutton-fat*" deposit. Short bacilli have been isolated in this variety of keratitis punctata by

Snellen, jun,* but this observation requires further confirmation, and is opposed to the experience of others. The presence of keratitis punctata is generally indicated by a fine grey infiltration of the posterior layers of the cornea which accompanies the deposit.

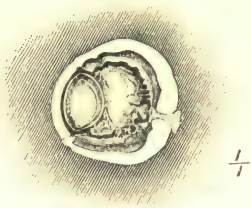


FIG. 106.—Phthisis bulbi.

The whole globe is much reduced in size; the anterior chamber is abolished, the vitreous is shrunken, and the retina detached.

At this time there may be no sign of iritis, but in a variable space of time the ordinary signs of iritic inflammation appear, with the formation of posterior synechiæ, and occasionally hypopyon. If the cornea is sufficiently clear, the vitreous will now be seen to be hazy, and frequently peripheral spots of buff-coloured choroidal effusion can be made out; whilst opacities may also

appear in the lens, especially at its posterior pole. The increase in intra-ocular tension is accompanied by ciliary tenderness and by dull aching; sometimes by excruciating pain from pressure upon the ciliary nerves. From the same cause the pupil is generally less contracted than in other forms of iritis, and may sometimes be considerably dilated, a feature that may cause an unwary surgeon to neglect the use of atropine (see "*Treatment*"). The sight is always seriously affected, giving a good indication of the state of the vitreous where a direct examination cannot be made.

If the disease continue unchecked, the sclerotic corresponding to the ciliary region will become thin and of a bluish colour from the ciliary processes shining through it, and occasionally staphylomatous. The lens and vitreous, which depend for their nourishment upon the ciliary glands (see "*Nutrition of the Eye*," page 195), will still further suffer, the former becoming completely cataractous, and the latter shrinking.

* '*Ophth. Rev.*,' 1894, p. 259.

Progressive choroiditis and detachment of the retina from the loss of support usually afforded by the vitreous destroy the last remnant of vision, and the globe then softens and atrophies (phthisis bulbi) (see Fig. 106).

The other danger to be feared is, that even if the inflammatory process is arrested, the pupil may become completely closed with the formation of an iris bombé, or total posterior synechia, and subsequent destruction of the eye (see page 210).

Pathology.—There have been few diseases the pathology of which has given rise to so much discussion. Various hypotheses as to its origin have caused it to be designated keratitis punctata, descemitis, and aquo-capsulitis. The knowledge we now hold concerning the nutritional fluid of the eye and its source in the ciliary glands, together with the clinical features of the disease above described, point quite definitely to the ciliary glands as the starting-point of the disease, and explain the constant involvement of the vitreous and the late manifestation of definite symptoms of iritis. The increased tension that accompanies the abnormal depth of the anterior chamber must not be regarded as true glaucoma: there is no doubt some impediment to the exit of fluids at the iritic angle; but the latter is widely open, and the tension in the main is due to hypersecretion. In the later stages of the disease, a true secondary glaucoma may be induced by closure of the pupil, and the formation of iris bombé or total posterior synechia, in which case the condition of the anterior chamber will then be a clear indication of the cause of the maintained increased tension. The distinction between the two is a matter of considerable importance in deciding what method to adopt to lower the intra-ocular pressure (see Treatment).

Prognosis.—This is fairly good, provided that the treatment is commenced early and prosecuted energetically. The disease is apt to become chronic, and relapses are also frequent. Complete recovery occurs in some instances, but most commonly the sight is permanently damaged.

Treatment.—It is necessary in this, as in other forms of irido-cyclitis to get the pupil dilated; but we are confronted with the increase in intra-ocular tension, which seems to contra-indicate the use of mydriatics. Atropine nevertheless should be used, but employed with caution, commencing with weak doses; and in many cases the heightened tension gradually disappears as the pupil is brought under its influence. Hot bathing, as described on page 201, is very useful, and proves very comforting to the patient. Leeches may also be employed to relieve pain and congestion, and dark protective goggles should be worn. Medicinal treatment is very important, and should be on the lines already laid down in dealing with the various forms of iritis. In spite of these methods of treatment, abnormally high tension and severe pain will



FULL SIZE

FIG. 107.—Paracentesis needle for tapping the anterior chamber.

sometimes persist, and it then becomes necessary to resort to paracentesis of the anterior chamber to relieve the pressure. The operation is simple, but very painful, unless carefully performed, on account of the sudden release of pressure. A lance-shaped needle with not too broad a blade (Fig. 107) should be used, and the opening in the cornea made very obliquely, so that the aqueous drains slowly away through a small valvular aperture. In this way the patient is saved much suffering, and the risk of intra-ocular hæmorrhage reduced to a minimum. After the paracentesis, atropine should again be employed, and in a certain number of cases the tension will remain permanently reduced. In other cases, however, tension returns, and the operation may have to be repeated several times before permanent improvement takes place. This operation is much to be preferred in the acute stages of the disease to iridectomy, which some surgeons have recommended from a mistaken conception of the pathology of the heightened tension. Iridectomy will, at this stage, only relieve in the same way as paracentesis, and will probably do real harm, for the operation upon an inflamed tissue is very likely to cause an exacerbation of the symptoms, with the formation of fresh adhesions. So, too, eserine should *never* be used in these cases to reduce the intra-ocular tension, for it increases the iritis, and consequently the danger of the pupil becoming closed. In the later stages, if, in spite of treatment, the pupil has become closed, an iridectomy is the proper course to pursue, as the only means left of saving the eye.

2. RECURRENT CHRONIC CYCLITIS.—Under this heading we refer to a special class in which the cyclitis occurs as a primary disease and seems to be always due to some constitutional defect. This form of cyclitis is a comparatively rare affection, but it is sufficiently frequent to deserve careful study, as it is very destructive to the eye. The patients are generally women, and the causes have been usually menorrhagia, profuse leucorrhœa, and amenorrhœa. Occasionally, however, the affection occurs in men, and in them the disease has been clearly referable to nervous exhaustion from overwork combined with great mental anxiety.

Constitutional cyclitis is a disease of long duration, very recurrent, and but slowly amenable to treatment. Its attacks will generally last from six weeks to three months, or longer. We have known several cases of cyclitis in females which have extended over periods of from eight to twelve years, the attacks recurring at intervals of from three to six months.

Symptoms.—The disease usually commences on one side of the cornea in the ciliary region with a small patch of a purplish-red colour closely resembling episcleritis. This gradually extends, and soon a bluish-red halo exactly corresponding with the ciliary region surrounds from one third to the entire circumference of the cornea. When only a portion of the region surrounding the cornea is affected, the purplish red shades off at each extremity into the colour of the rest of the eye. The margin of the cornea corresponding to the deep red zone is slightly blurred and indistinct, and seems to blend with the sclerotic

(**sclerosing keratitis**). In some cases the whole surface of the eye is red; but the peculiar purplish tint which corresponds with the ciliary region is always distinct, and serves to mark well the nature of the affection. As the disease progresses the iris becomes involved, the aqueous grows serous, and there is occasionally hypopyon. The sight is impaired, in some cases to a great extent, and the tension of the globe is frequently increased. If the disease continue unchecked, the sclerotic corresponding to the ciliary region will become thin, of a bluish colour, from the ciliary processes shining through it, and occasionally staphylomatous; the sight will continue to fade, and ultimately the eye will become blind. Through all the stages of the disease there is pain in the eye, varying in degree from tenderness to a dull, heavy aching; there is frequently also pain in the brow and down the inner side of the nose.

Treatment.—Locally all the methods adopted for the relief of iritis are suitable in these cases. Tonics of iron, strychnine, or quinine, combined with the mineral acids, are suitable for cases proceeding from debility. If menstrual disturbances appear to be the cause, special attention must be directed to their relief. Opiates will often be required to relieve pain and produce sleep.

If the disease resists all medicinal treatment, or if the tension of the globe be increased, or if the sclerotic around the cornea become thinned and bluish, an iridectomy should be performed. It is usually attended with admirable results, and exercises a wonderful influence in arresting the recurrence of the attacks.

3. **TRAUMATIC CYCLITIS**.—Cyclitis from an injury to the eye may be primary, and originate simultaneously with iritis as the immediate result of the injury; or it may be secondary to an inflammation of the iris which the injury has excited.

The injuries which are most liable to produce cyclitis are penetrating or incised wounds in the ciliary region, the lodgment of a foreign body within the eye, a dislocation of the lens, or the forcible removal of a piece of opaque lens capsule, especially if during the operation any drag has been made on the ciliary processes.

Symptoms.—Pain in the ciliary region, with marked tenderness on pressure; a pinkish zone around the cornea from distension of the ciliary vessels; photophobia and lacrymation; and turbidity of the vitreous from inflammatory exudations into it from the ciliary processes. After wounds in the ciliary region, large masses of lymph or pus may be frequently seen with the unaided eye, lying behind and to one side of the lens. The iris always participates in the inflammation, even when the disease originates in the ciliary body; its striæ become indistinct and its colour changed; the pupil sluggish or inactive; and posterior synechiæ are formed. The aqueous grows serous and turbid, and there is frequently hypopyon. The sight is greatly impaired, and the tension of the globe is often increased.

Prognosis.—This is very unfavourable. Even if the inflammation subsides under treatment, the eye generally becomes soft and partially shrinks, and all sight is destroyed; but the great danger to be feared is

lest, while endeavouring to save the injured eye, the other should become affected with "sympathetic ophthalmitis."

Treatment.—This should be conducted on the principles already described under "Traumatic Iritis" (page 205). The results of traumatic cyclitis are so unfavourable, both as respects the injured eye and the risk to which the sound one is exposed from sympathetic ophthalmitis, that if the inflammation does not yield rapidly to treatment we would strongly urge the removal of the globe, and this especially if the accident be a wound in the ciliary region.

4. **SECONDARY CYCLITIS.**—Inflammation of the iris, produced either by injury or disease, may spread first to the ciliary body, and then to the choroid; and in like manner an inflammation which has started in the choroid may, by extension, give rise to cyclitis and iritis.

This secondary cyclitis is always a severe complication of the original disease, and sometimes leads to the complete loss of the eye. It is often induced by syphilitic inflammation of the iris or choroid; it also frequently follows traumatic iritis, and it thus becomes one of the causes of failure after the operation for extraction of cataract.

The Symptoms are similar to those described in the preceding section, but in this secondary form of cyclitis the advent of the extension of the inflammation to the ciliary body is marked by an addition to the severity of the pre-existing symptoms;—there is increased vascularity, photophobia, and lacrymation; pain in the ciliary region, which is increased by pressure, and frequently also an increased tension of the globe. The vitreous, also, is very apt to share in the inflammation, and becomes turbid and, in severe cases, fluid.

Prognosis.—The inflammation may subside under judicious treatment, but the prognosis depends greatly upon the nature of the primary inflammation.

Treatment.—The local treatment required is similar to that described for iritis. The medical treatment depends upon the cause of the primary inflammation, and will be found described under the various forms of iritis.

Results of Recurrent Iritis and Cyclitis.—The great danger of iritis lies in the tendency of the pupil to become closed, so that the communication between the anterior and posterior chambers is shut off, and the nutritional fluid of the eye is no longer able to pass from one to the other to make its exit at the angle of the anterior chamber (*see also* "Nutrition of the Eye"). Iritis closes the pupil in two ways, both of which are frequently seen in the same case: either a complete ring of adhesions may bind the pupillary margin of the iris to the anterior lens capsule (**exclusion of the pupil**); or bands of organised lymph may form a membranous curtain, bridging over the pupillary space (**occlusion of the pupil**). The closure of the pupil is followed by a gradual accumulation of fluid behind the iris, which is thereby arched forwards in the manner depicted in Figs. 108, 109 (**iris bombé**), a condition easily recognised by the state of the anterior chamber, which is deepest in the centre, and becomes progressively shallower as the

periphery is approached. As the periphery of the iris is pressed towards the cornea, the angle of the anterior chamber becomes first narrowed and then obliterated, as in Figs. 108, 109, and subsequent adhesions will finally cause an irremediable union between the two structures. In this way **secondary glaucoma** with increased tension is induced by closure of the pupil, and when this condition is once established the eye is soon lost by the atrophic processes that ensue. The lens becomes cataractous and shrivels, the vitreous becomes hazy, loses its consistency, and shrinks, whilst the retina, from loss of support, falls forwards and becomes completely detached. Finally, the whole globe begins to shrink (**phthisis bulbi**), the heightened tension is replaced by the softness of general atrophy, and the eye is ultimately represented by an atrophic stump.



FIG. 108.—Exclusion of the pupil. Iris bombé. Secondary glaucoma. (After Priestley Smith.)

When the ciliary body is primarily concerned, or shares to a large extent in the inflammation, the formation of an iris bombé may not occur. On the contrary, the exudation poured out behind the iris may be sufficiently intense to glue down the whole of the posterior surface of the iris to the lens capsule, and so cause obliteration of the posterior chamber (**total posterior synechia**). In such a case the anterior chamber, instead of appearing crater-like, as with an iris bombé, is shaped like an inverted **V**, the point of the **V** being represented by the pupil where the anterior chamber is shallowest. Increased tension accompanies the formation of total posterior synechia, and atrophy with softening and shrinking of the globe as above described, ultimately result, the shrinking of the intra-ocular contents being accompanied by still further retraction of the periphery of the iris.

Atrophy of the Iris.—In cases of long-standing disease the wasting of the iris tissue is marked by loss of lustre and alteration in colour. The characteristic mottling disappears, and in places a greyish-white fibrillation shows where the pigment has disappeared.

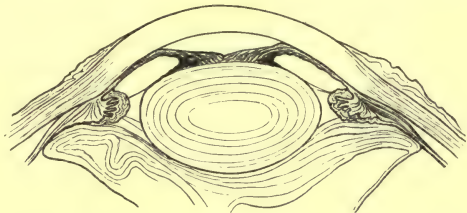


FIG. 109.—Occlusion of the pupil. Iris bombé. Secondary glaucoma. (After Priestley Smith.)

THE OPERATIVE TREATMENT OF RECURRENT IRITIS AND CYCLITIS.—It was formerly held that the presence of

posterior synchiæ favoured the recurrence of iritis by dragging on the iris and promoting irritation, and that iridectomy acted advantageously in preventing these recurrences by setting free a portion of the pupil. Experience has shown, however, that the operation has a very uncertain influence in this respect; and that recurrences depend chiefly upon the

type of iritis, being especially apt to occur in rheumatic forms of iritis, but less frequent when the inflammation is of syphilitic origin. Iridectomy is, however, of great value when, in spite of careful treatment, the pupil is becoming gradually excluded by synechiæ, or occluded by inflammatory membrane; for by this method a free passage is made for the circulation of the nutritional fluid, and when the pupil is occluded the operation greatly improves the sight.

The time for operation must be well judged to ensure success, for if operation is delayed too long it may be impossible to obtain a satisfactory coloboma on account of the breadth and firmness of the adhesions, and the friability of the iris. Or, again, attempts to detach the iris when firmly adherent may easily result in tearing the lens capsule, with the subsequent formation of a traumatic cataract; or, in other cases the nutrition of the eye will have suffered to such an extent that little or no benefit will be derived from operative interference. Therefore the surgeon should, when possible, advise iridectomy as soon as he perceives that the disease is getting out of control, and that the formation of numerous inflammatory bands and synechiæ threatens the complete closure of the pupil and the nutrition of the eye in the event of another recurrence.

The operation should in all cases be performed when the eye is quiet between the attacks of iritis; for if undertaken when the eye is inflamed, the result will be to increase the iritis, and the operation will be probably rendered of no avail by the formation of fresh adhesions, which will shut off the coloboma and re-close the pupil.

In performing the iridectomy it is only necessary, when the operation is undertaken in good time, to open up the pupil, and a large peripheral coloboma should therefore be avoided for optical reasons; unless there is reason to believe that the iritic angle is closed by adhesions, in which case merely opening the pupil will not be of any benefit, and the operation should be performed as for primary glaucoma. If, however, the iritic angle has been long and firmly closed, any form of iridectomy will probably fail, and a subsequent sclerotomy (*see* page 244) will then offer the best chance of relief.

Sometimes the pupillary border of the iris will become detached and remain adherent to the lens capsule when drawing out the iris from the wound previous to excising it. No attempt should afterwards be made to get it away, as it in no way interferes with the good effect of the operation.

The iridectomy should, as a rule, be made upwards, in order that the drooping of the upper lid may limit the dazzling caused by the coloboma; but if there is one spot where the iris is more free than elsewhere, the operation should be performed there; and this point may be cleared up by the instillation of atropine.

If a satisfactory iridectomy cannot be made, and the pupil remains closed, it will be necessary to extract the lens, and subsequently to deal with the closed pupil by an iridotomy (*see* page 223).

A condition of total posterior synechia is almost hopeless, and only amenable to treatment by removal of the lens, the extraction being difficult, and probably accompanied by considerable loss of vitreous.

Finally, operative interference is clearly contra-indicated if the eye is abnormally soft, and when light perception and projection are faulty or lost.

For details of performing iridectomy *see* page 221.

INJURIES OF THE IRIS AND CILIARY BODY.

HYPHÆMA, or Hæmorrhage into the Anterior Chamber.—This is the most common form of intra-ocular hæmorrhage, and, at the same time, the least severe. It may vary in extent from a few drops of blood to a quantity sufficient to fill both the anterior and posterior chambers.

The most usual causes of hæmorrhage into the anterior chamber are either rupture of one or more of the superficial vessels of the iris; or a distinct laceration of its structure, or a separation of a portion of the iris from its ciliary attachment (coredialysis). The blood, as it is effused from the lacerated vessels of the iris, sinks at once to the bottom of the anterior chamber, quickly coagulates, and, if not large in quantity, may be seen as a small clot occupying its lower part, and moulded as it were to it.

Prognosis and Treatment.—When the hæmorrhage is confined to the anterior chamber, and there is no rupture of any of the external tunics of the eye, the case generally does well. The blood is first macerated by the aqueous humour and then rapidly absorbed. In this, as indeed in all cases of injury, rest to the eyes is essential: all work should for a time be forbidden, and the eyes should be shaded from strong light. Atropine should be employed until all danger of inflammation has passed. Cold applications are the most suitable, and afford much comfort to the eye. A double fold of linen, wet with iced water or boracic lotion, may be laid over the eye, and kept in its place with a single turn of a light bandage, and moistened from time to time with a little fresh lotion; or, if the eye be painful, a cold lotion of belladonna may be used in the place of the water-dressing. If iritis sets in it must be treated on the lines already laid down (*see* "Traumatic Iritis").

IRIDODIALYSIS, or COREDIALYSIS, is a detachment of the iris from its ciliary border, by which a new pupil is frequently formed. It is generally caused by sharp blows on the eye, such as with the handle of a whip, with the cork from a bottle of soda-water, or an accidental back blow from the hand of another person, or, indeed, from any sharp sudden violence. Coredialysis may be associated with rupture of the external coats of the eye, but in the majority of cases it has not this severe

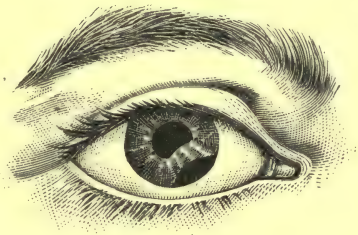


FIG. 110.—Extensive coredialysis caused by a squib which struck the eye as it exploded.

complication. The separation of the iris from its ciliary connection is always immediately followed by free bleeding, often sufficient in quantity to fill the whole of the anterior chamber with a blood-clot. The extent of the coredialysis varies very much: in some cases the detachment is so small as scarcely to be visible after all the blood has been absorbed; whilst, in other instances, a third or even more of the iris may be loosened from the ciliary body.

The pupillary border of the iris corresponding to the dialysis is paralysed from a tearing through of the ciliary nerves which supply it, and that part of it is uninfluenced by the action of light and shade. The complete circle of the pupil is thus destroyed—a defect which is most observable when the pupil is dilated. An annoying and not infrequent sequela of this accident is monocular diplopia, caused by the presence of a double pupil.

The Prognosis of coredialysis when there is no rupture of the external coats of the eye is favourable. A guarded opinion should, however, be always given, as the blow which has force enough to cause a coredialysis may also produce cataract or posterior hæmorrhage.

Treatment.—The same as for “Hyphæma” (*see* preceding section).

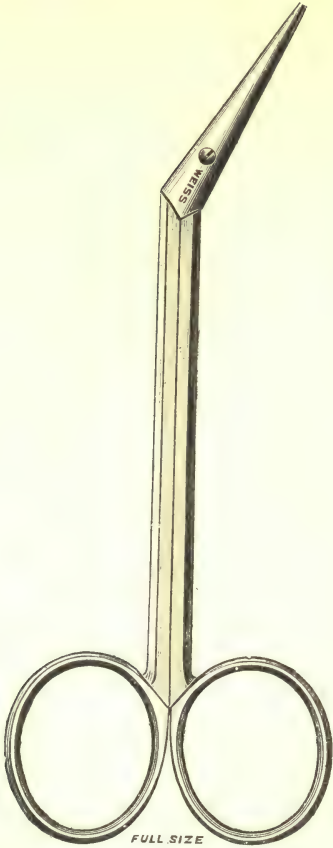


FIG. 111.—Iridectomy scissors.

LACERATION OR RUPTURE OF THE SPHINCTER IRIDIS may occur as the result of severe blows. The pupil is widely dilated and immobile; and careful examination may reveal one or more minute lacerations about the pupillary border. Very rarely the sphincter is completely ruptured, and a radial split then stretches from the pupillary margin towards the periphery. Some permanent dilatation of the pupil is apt to persist after this accident.

No special treatment is usually required beyond rest, which is best maintained by keeping the *other* eye under atropine, so as to avoid all attempts at consensual reflex action on the part of the injured pupil. If inflammation sets in, it must be treated as already detailed under “Traumatic Iritis.”

PROLAPSE OF THE IRIS.—Penetrating and incised wounds of the cornea are generally followed by immediate prolapse of the iris. The extent of the protrusion varies with the size and the position of the

wound. A small penetrating wound near the margin of the cornea is more likely to be attended with a prolapse than a large incised one near the centre.

Prolapse of the iris is very commonly associated with injury to the lens; but, as a rule, we have first to direct our attention to the treatment of the prolapsed iris, leaving the traumatic cataract to be dealt with at a future period if necessary.

A prolapse of the iris may be treated in three different ways:

1. By removing with a pair of fine scissors the prolapsed iris.

2. By a compress applied externally over the closed lids.

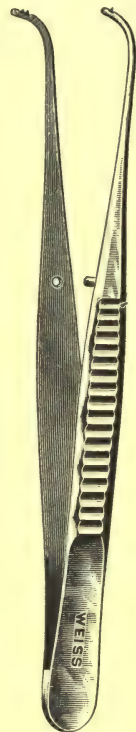
3. By frequent puncturings of the prolapsed iris with a fine needle.

1. By removing with a Pair of Scissors the Prolapsed Iris.—There is no doubt that when it can be accomplished the best treatment is to excise the prolapsed iris cleanly from the wound, so as to allow its edges to fall together. In a recent case, the speculum having been introduced between the lids, the prolapsed iris should be seized with a pair of iris forceps, drawn well-out, and then divided close to the wound with a pair of fine scissors. A drop of eserine or atropine, according as the corneal wound tends towards the periphery or the centre respectively, may be then dropped into the eye, so as to draw the iris in the most favourable manner from the wound. The lids are then closed by a firm compress. If eserine be employed, the case must be carefully watched for any signs of iritis, upon which atropine must, at all costs, be substituted.

2. By Compress.—When, either from the time which has elapsed since the accident, or from the state of the wound, it is found impossible or deemed inadvisable to excise the prolapsed iris, a compress should be applied over the closed lids. It keeps the eye in a state of rest, excludes light, tends to prevent an increase of the prolapse, and promotes the formation of a flat cicatrix.

3. Frequent Puncturings of the Prolapse with a Fine Needle are most useful in cases of extensive prolapse of the iris near the margin of the cornea of long standing, and where the prolapsed iris has become adherent to the edges of the wound and coated with lymph. In such cases it is impossible to excise the protruded iris, and frequent puncturings of it do good. The prolapse should be pricked at one or two points, so as to cause the aqueous to escape and its sides to collapse, and at the same time to permit the edges of the wound to close upon it.

The General Treatment must be strictly soothing, and great care should be taken of the eye for at least six months after a wound



FULL SIZE

FIG. 112.—Iris forceps.

followed by prolapse of the iris, even though the lens may have escaped all injury. Both eyes should be shaded, and all strong lights should be carefully excluded. The eyes should be protected from glare when out of doors by spectacles with dark neutral-tint glasses.

If there be much reaction after the accident, two or three leeches should be applied to the temple of the injured eye, and three or four times during the day the eye should be bathed with a belladonna lotion, or it may be fomented with a warm decoction of poppy heads. As a rule, even when eserine has been deemed advisable in the first instance, it is wise to substitute atropine as soon as the anterior chamber has re-formed, and to continue its use until the eye is white again.

No prolapse of the iris should be regarded very lightly; for complete blindness may follow from what has appeared at first a comparatively slight injury.

WOUNDS OF THE CILIARY BODY.—Wounds of the ciliary region, a zone extending into the sclerotic for about 5 mm. from the corneal margin, are especially dangerous, on account of their liability to induce an attack of sympathetic ophthalmitis in the other eye.

In many cases the severity of the injury is such that the eye is hopelessly lost as a visual organ, in which case no hesitation should be felt in at once excising it.

In other less severe cases the wound should be carefully cleaned, and any particles of dirt, etc., adhering to the lips of the wound cut away, as well as any prolapse of iris or ciliary body. Strong antiseptics are not advisable, and are likely to do more harm than good by irritating the eye. If the wound gapes, the edges may be brought together by a fine suture, and a little of the Ung. Atrop. (F. 57) should then be placed within the closed lids, and a dry compress of some absorbent dressing applied.

If traumatic cyclitis set in, the treatment recommended on page 210 should be adopted. (See also "Wounds of the Sclerotic," page 182.)

TUMOURS OF THE IRIS AND CILIARY BODY.

CYSTS.

All forms of cystic disease of the iris are rare. They may be classified as (1) *Implantation cysts*; (2) *Retention cysts*; (3) *Uveal cysts*; (4) *Parasitic cysts*.

IMPLANTATION CYSTS may occur after a penetrating wound of the cornea in which the iris has suffered by prolapse or puncture. A particle of epithelium derived from adjacent structures, the skin of the lids, the conjunctiva or the cornea, or the root-sheath of an eyelash, may be carried into the anterior chamber with the instrument and become embedded in the iris, where it commences to grow, and forms a round or oval swelling projecting from the anterior surface of the iris. A cystic growth may attain considerable size without causing the patient any inconvenience; but, on the other hand, it is very liable to set up

great irritation, and may lead to glaucoma by blocking the angle of the chamber. The contents of these cysts are subject to considerable variation, depending on the original characters of the implanted epithelium. In most cases they are filled by a translucent fluid (*serous cysts*), whilst in others the contents are pultaceous or almost solid, giving the cyst a whitish opaque look (*pearl tumours*). They frequently contain cholesterin, fat-cells, sebaceous material, and in many instances fine hairs have been discovered. Their walls are formed by attenuated iris tissue, lined internally by laminated epithelium. Masse* has succeeded in artificially producing similar cystic growths by grafting particles of epithelium upon the irides of rabbits.

Treatment.—Excise the cyst with the portion of iris to which it is attached. If the cyst is small and the iris not adherent or atrophied from the irritation induced by the cyst, this may be an easy matter; but in some cases it may prove impossible, and the eye may ultimately have to be excised. When the cyst is so large that the corneal section over the region of the cyst cannot be made in the ordinary way without much danger of wounding the cyst, a plan suggested and carried out by Nettleship may answer the purpose. A small incision is made just above and below the cyst, and the two incisions joined by completing the section over the bulging cyst area with a blunt-pointed canaliculus knife.

RETENTION CYSTS.—In rare cases serous cysts of the iris have formed without any history or signs of previous injury. Some doubt has been thrown on such cases, because of the absence of secreting cells in the iris tissue, and it is possible that in some instances an injury may have been overlooked or forgotten. Nevertheless a distinctive feature of these spontaneous cysts is the cyst-lining, which consists of a single layer of cells in contra-distinction to the laminated epithelium above mentioned as characteristic of implantation cysts. Schmidt-Rimpler† believes that these cysts are due to the occlusion of one of the numerous recesses or crypts in the iris stroma, which probably serve as lymph-channels, and which are lined by a dipping down of the anterior epithelium of the iris.

The clinical appearance of these cysts and their treatment is similar to that described in implantation cysts.

UVEAL CYSTS.—Separation sometimes takes place between the two layers forming the “*pars ciliaris retinæ*,” and a space is thus formed which becomes filled with fluid. The eyes in which these cystic spaces occur are generally more or less destroyed by inflammation of long standing, and the cysts are of a degenerative nature; but in rare cases, such as those described by Eales and Sinclair‡ and Zimmerman,§ the cyst is of an idiopathic origin, and the pupil is invaded by a pigmented tumour closely simulating the appearance of a

* ‘*Ophthal. Hosp. Rep.*,’ vol. vi, p. 12.

† ‘*Arch. f. Ophth.*,’ Bd. xxxv, S. 1.

‡ ‘*Trans. Ophth. Soc. U. K.*,’ vol. xvi, p. 56.

§ ‘*Ann. of Ophth.*,’ vol. vi, 3, p. 1.

melanotic sarcoma, but distinguishable probably by a long history and slow growth, and perhaps, as in Eales' and Sinclair's case, by observing fine vibratory movements on close examination when the eye is moved. The pressure of such a tumour may set up iritic inflammation with gluing of the pupil to the lens capsule, in which case the bulging of the periphery of the iris by the tumour behind it will, as pointed out by Collins,* produce a condition of iris bombé indistinguishable from that arising from a purely inflammatory cause. Upon attempting an iridectomy to re-establish communication with the anterior chamber, the withdrawal of the iris will still leave the posterior wall of the cyst attached to the lens capsule, and the operation will not, of course, be followed by any benefit to the patient.

Collins has further pointed out the pathological resemblance of these cysts to cases of detachment of the retina proper, in which the hexagonal pigment-cells corresponding to the anterior layer of the "pars ciliaris retinæ" always separate away from the rest of the retina, which is represented by the posterior layer. This line of separation in each case marks the embryological division between the outer and inner walls of the secondary optic vesicle.

PARASITIC CYSTS.—The cysts of *cysticercus cellulosæ* occasionally invade the anterior chamber, or may appear embedded in the iris and ciliary body. They look like transparent vesicles with a slight constriction at one part which divides the head from the body, the former being also marked by a dark spot, which may exhibit oscillatory movements as the head is slightly protruded or withdrawn. When originating in the iris, they should be removed by a method similar to that recommended in the treatment of implantation cysts. When they invade the anterior chamber from the vitreous, the eye will already have been lost, and should be excised. Other parasites have, on rare occasions, been seen, such as the *Filaria sanguinis hominis*, etc.

SOLID TUMOURS OF THE IRIS AND CILIARY BODY.

HYPERPLASIA OR ECTROPION OF THE UVEA.—The uveal pigment lining the posterior face of the iris may sometimes encroach on the anterior surface, or form small pigmented nodules projecting into the pupil. The condition may occur either as a congenital defect, or may arise in cases of long-standing disease from atrophy and shrinking of the iris stroma, which leaves the uveal pigment exposed at certain points. Sometimes particles of proliferated pigment-cells become detached and float free in the anterior chamber.

SARCOMA OF THE IRIS OR CILIARY BODY is a rare tumour more or less pigmented. It runs a course similar to other intra-ocular sarcomata, spreading both inwards and outwards, so that the sclerotic ultimately becomes perforated by the growth in the neighbourhood of the corneal limbus.

* 'Researches into Anat. and Path. of the Eye,' p. 53.

Treatment.—If the growth is seen in its very earliest stage, it may be sufficient to remove it by free excision of the iris; but if the iris is affected right up to its root, enucleation of the globe should be performed, although the eye may still retain good vision.

CARCINOMA OF THE CILIARY BODY.—Primary carcinoma occasionally arises in the glandular epithelium that lines the ciliary processes. More frequently, though still a rare disease, the growth is a secondary deposit of cancer. The only treatment is, of course, to enucleate the globe as soon as possible.

TUBERCLE OF THE IRIS OR CILIARY BODY may occur in two forms, either as miliary deposits or as a solitary caseating nodule. Both varieties are rare, the latter especially so, and both are most usually, if not always, secondary to tuberculous deposits elsewhere. On the iris, miliary tubercle appears as discrete greyish points, generally situated near the periphery of the iris, which is thickened and inflamed. There is the usual ring of ciliary congestion, and the cornea, especially in the situation of the nodules, is hazy from infiltration, whilst in some cases there is a brown mottling of Descemet's membrane (*keratitis punctata*). Subjective symptoms of pain and photophobia are not usually marked. The disease is very intractable, some of the nodules remaining apparently unchanged for several weeks, whilst others disappear only for fresh points to take their place. Complete recovery has been reported in a few cases after a long and tedious illness, but generally the prognosis is unfavourable, and the eye is eventually lost by a slowly progressive plastic inflammation.

The caseating nodule may appear in company with miliary tubercle, or as an isolated yellowish growth upon the iris, in which case its nature may be matter of doubt until the microscope is employed. It does not seem to have the same tendency to cause iritis as does miliary tubercle, but grows steadily, eroding everything with which it comes in contact, until at last the cornea is perforated and the eye destroyed.

Treatment.—No special treatment beyond that advised for iritis in general (page 201) can be advised for tuberculous irido-cyclitis. If we have reason to suppose that tubercle of the iris is a primary focus of infection, there can be no doubt that the eye, providing one only is affected, should be removed. In other cases, if the infection appears strictly limited to a small circumscribed portion of the iris, an attempt may be made to remove the infected portion of the iris. Enucleation is the only possible form of treatment for the caseating nodule, unless it is seen at its very earliest stage, when it may be possible to remove the growth by an iridectomy.

GUMMA is a rare manifestation of the tertiary stage of syphilis. It appears on the iris as a circumscribed yellowish growth accompanied by considerable inflammation. In the neighbourhood of the growth the iris appears especially thickened and congested, and large tortuous vessels surround the base of the tumour, and creep over its surface. Sometimes one of these vessels ruptures and a corresponding splash of

hæmorrhage is seen, or in severe cases there may be *hyphæma*. The yellowish growth, flecked with lymph and streaked with new vessels, together with the changes in the iris and the presence of some corneal infiltration, form a very characteristic picture. A gumma may likewise have its starting-point in the ciliary body, in which case the external evidence will probably be scarcely sufficient to allow of a positive diagnosis, unless the eye is removed, or the inflammation spreads to the iris. The history, combined with a local bulging of the sclera, and symptoms of cyclitis, will, however, materially help.

The *prognosis* is fairly good, and the eye may recover with useful sight if the diagnosis is made early and anti-syphilitic treatment energetically adopted. The growth, however, runs a speedy and severe course, and if untreated the eye will soon be lost. For treatment see "*Syphilitic Iritis*," page 202.

OPHTHALMIA NODOSA is a very rare disease, due to the irritation set up by the hairs of certain caterpillars. The best description of the affection is given by Lawford,* from whose excellent article we quote freely. In most of the few recorded cases there has been a definite history of the eye being struck by a caterpillar thrown in play, etc., the blow being very shortly followed by signs of violent irritation. The conjunctiva and episcleral tissue are congested; the cornea hazy, with much accompanying photophobia; and an obstinate irido-cyclitis of a peculiarly relapsing nature is set up. The most characteristic feature of the disease is the formation of small, seed-like nodules, which may be mistaken for tubercle, and which appear sometimes in considerable numbers in the ocular and palpebral conjunctiva or in the substance of the iris. Each nodule consists of a collection of cells closely resembling in structure a nodule of tubercle, but having embedded in the centre a fine hair derived from the caterpillar. The caterpillar which in most cases seems to have caused the disease in this country is the "*Bombyx Rubi*," or caterpillar of the fox moth. The migration of the hairs into the tissues is probably due to the rubbing of the eye, aided by the peculiar structure of the hairs themselves.

Treatment.—The iritis must be combated in the usual way by atropine and local applications, and, in addition, the nodules should be removed. If a nodule is present in the iris, it may be removed by excising the affected portion of iris.

Spontaneous Ciliary Hæmorrhage.

Sudden and spontaneous hæmorrhage from the ciliary vessels, or from the vessels in the anterior portion of the choroid, occurs occasionally in young and middle-aged persons. It is sudden in its attack, and very liable to recur. The symptoms are sudden loss of sight, in some cases partial, in others complete. If the pupil be dilated with atropine, a blood-clot may be seen either between the lens and the ciliary processes, or behind the lens and lying upon the front of the

* 'Trans. Ophth. Soc. U. K.,' vol. xv, p. 210.

vitreous. In the latter class of cases some of the blood will generally find its way into the vitreous, and will then be seen with the ophthalmoscope as dark floating masses.

The prognosis in these cases is much more favourable than in retinal hæmorrhage; when the blood-clot is anterior to the lens, the recovery is usually almost complete, but when the blood has been extravasated into the vitreous, although the patient may regain much of his lost sight, yet the recovery is slow. The unfavourable point in these cases is the liability to recurrence, as after each attack the eye becomes more damaged, and if the recurrences be frequent or severe, the sight may be destroyed.

Treatment.—Rest for the eyes by abstention from work, and atropine. The patient should be examined for any organic mischief, and treated accordingly.

OPERATIONS ON THE IRIS.

Iridectomy.—Instruments required :—(1) Speculum (Fig. 130); (2) fixation forceps (Fig. 132); (3) Graefe's knife (Fig. 113), or keratome (Fig. 114); (4) iris forceps (Fig. 112); (5) iris scissors (Fig. 111), or forceps scissors (Fig. 117); (6) curette (Fig. 125).

The operation may be performed either with a narrow Graefe's cataract knife or with a lance-shaped knife. If the anterior chamber is shallow, we much prefer a Graefe's cataract knife, with which there is less danger of wounding the lens, as the point of the knife is kept in front of the iris, and does not cross the pupil. A spring-stop speculum having been placed between the lids, the operator, standing behind the head of the patient, seizes with a pair of forceps the conjunctiva close to the lower margin of the cornea on the nasal side, and with a narrow Graefe's knife enters its point in the outer and upper portion of the margin of the corneo-sclerotic junction, first directing it obliquely downwards towards the pupil until the point is seen in the anterior chamber; then, turning the point slightly upwards, he traverses the rim of the anterior chamber in front of the iris for not more than a quarter of an inch, and makes his counter-puncture; and then, cutting abruptly upwards, completes his section by forming a short conjunctival flap.

If the iridectomy be performed with the lance-shaped knife, the operator stands behind the head of the patient, and with a pair of forceps in his left hand he seizes the conjunctiva and subjacent fascia close to the cornea and opposite to the spot at which he is about to introduce the point of the iridectomy knife; whilst with his right hand he makes an incision in the sclerotic at about one line from the margin of the cornea, so that the point of the knife may enter the anterior chamber just in front of the ciliary attachment of the iris. In directing the blade of the knife across the anterior chamber, care should be taken to keep the point of the instrument slightly forwards, so as to avoid the risk of wounding the lens.

The surgeon now hands over the forceps, which fixed the eye, to his

assistant, who, if necessary, rotates the globe a little downwards, and steadies it whilst he excises a portion of the iris. If the iris is already prolapsed, as often happens, he at once seizes it with a pair of iris forceps; or, if not, he introduces the blades of the forceps through the wound and makes them grasp the iris near the pupillary border, and then, drawing a portion of it out of the wound, he cuts it off with a pair of fine scissors.

The method of dividing the iris depends on the effect desired. When only a small coloboma is needed, the scissors should embrace the whole of the extruded iris close down to the edge of the wound and detach it with a single snip. To make a broad coloboma, the section is

FIG. 114.

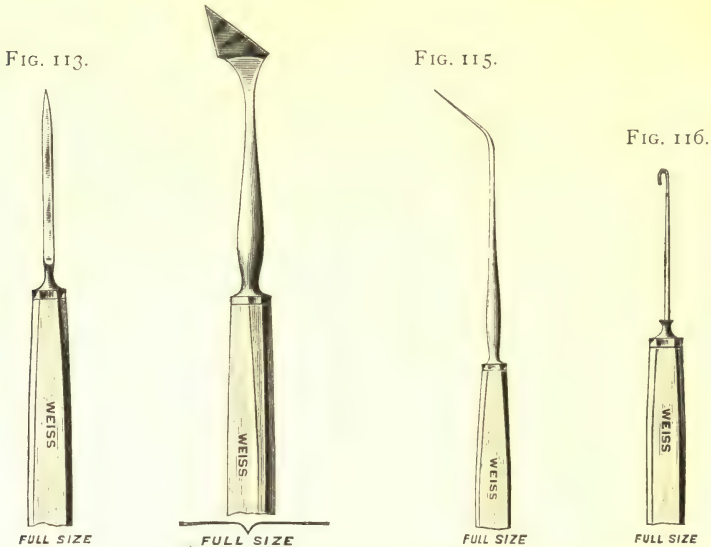


FIG. 113.—Author's modified Graefe knife for iridectomy. Length 23 mm. from the pitch; width 1 mm. This is both shorter and narrower than the ordinary Graefe knife, and is more easily manipulated if the anterior chamber is shallow.

FIG. 114.—The keratome or lance-shaped knife for iridectomy.

FIG. 115.—Side view of the keratome.

FIG. 116.—Tyrrell's hook for artificial pupil.

made at each angle of the incision, the iris in each case being drawn well towards the centre of the incision before the cut is made.

Before closing the eye the cut pillars of the iris should in all cases be gently smoothed back with the curette from the angles of the wound, so as to prevent any entanglement of the iris in the scar.

For special details in performing the operation for glaucoma *see* page 241, or for recurrent iritis *see* page 211.

Artificial Pupil.—To gain the full benefit which an artificial pupil will afford in properly selected cases, the cornea should be first very

carefully examined, and, if necessary, by oblique illumination with ophthalmoscopic light, to determine the part opposite to which an artificial pupil will be the most effective. The old theory that the coloboma should be made down and in, because it then most nearly corresponds with the line of visual axis, is fallacious, and an outward coloboma is as effective, though cosmetically not so desirable as an inward one. In examining the cornea, the two points to be noted are—(1) its transparency, and (2) its curvature;—that part should be selected which is the most transparent, and which has the most normal curve. Other things being equal, an upward coloboma is the least favourable, on account of the overhanging upper lid. An optical iridectomy should be as small as possible, so as to limit the dazzling caused by diffusion rays.

The operation most in use for the formation of an artificial pupil is iridectomy; but there are many cases for which it is not suited, and then one of the other two methods may be selected, according to the special indications which the eye may present—

1. With a broad needle and Tyrrell's hook.
2. By iridectomy.
3. By division of the iris with a pair of scissors—iridotomy.

1. To make an Artificial Pupil with a Broad Needle and Tyrrell's Hook.—The patient lying on a couch, a spring-stop speculum (Fig. 130) is to be introduced between the lids, so as to keep them apart. The operator, standing behind the head of the patient, with one hand seizes the conjunctiva and submucous tissue of the eye with a pair of forceps, so as to steady it, whilst with the other he makes an opening in the extreme margin of the cornea with a broad needle. Having completed the incision, the broad needle is to be withdrawn, and the eye being still held by the forceps, a Tyrrell's hook (Fig. 116) is to be passed *sideways* through the corneal wound into the anterior chamber and onwards across the iris to the pupil, when it is to be turned with the hook downwards, so as to catch the pupillary edge of the iris, and then to be slowly and carefully withdrawn from the eye. When the hook approaches the opening at the margin of the cornea, it must be again turned on its side, or a difficulty will be experienced in getting it out of the eye. As soon as the iris is drawn from the eye, the assistant should cut it off close to the cornea with one snip of a pair of fine scissors. The operation is now finished; the speculum should be removed from the eye, and a compress applied.

This operation is applicable to those cases where there is a pupil, or at least a portion of one, to the free edge of which the hook can be applied.

2. Artificial Pupil by Iridectomy.—By the operation of iridectomy, described on page 221, an artificial pupil may be made at any part of the circumference of the cornea.

3. Artificial Pupil by Division of the Iris with a Pair of Scissors, or Iridotomy.—This operation is suited to a special class of cases: those eyes in which there is *no lens*, and in which only a trace of a pupil remains, the iris appearing as a plane surface stretched tightly from the cicatrix to the circumference of the cornea.

The point of a small keratome (Fig. 114) is passed into the anterior chamber just within the corneo-sclerotic junction, and an opening made sufficiently large to admit easily the closed blades of De Wecker's forceps scissors (Fig. 117). The scissors are then to be introduced within the chamber, and the sharp-pointed blade made to penetrate the iris and to pass some distance behind it, when by one clip of the scissors the iris is divided and a good pupil made. If, however, owing to the iris having lost its natural elasticity, the edges of the cut should fail to retract so as to form a new pupil, a piece of the iris must be drawn out of the wound with a pair of iris forceps, and cut off with a pair of fine scissors, as in iridectomy.

The operation should never be attempted until all traces of inflammation have passed away for some months, so that the risk of inducing

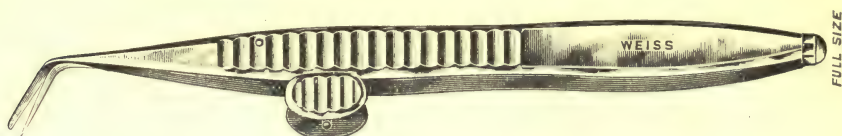


FIG. 117.—De Wecker's forceps scissors for iridotomy.

fresh iritis by the operation, and consequent reclosure of the pupil may be reduced to a minimum.

Operation for Removal of Prolapsed Iris.—(See page 215).

Treatment after Operations on the Iris.—The eye should be kept bandaged from ten days to a fortnight with a light gauze or gamgee dressing, which should be removed twice daily for gentle irrigation with tepid boracic lotion. At the end of this time dark neutral-tinted protectors may be substituted for the bandage, and these should be worn continuously until the eye has resumed its normal appearance. Atropine in the form of ointment (F. 57) or drops (F. 10) should be used throughout the healing stage, unless the operation has been for the relief of primary glaucoma, in which case it is to be avoided.

CHAPTER XV.

SYMPATHETIC OPHTHALMIA.

WHEN an eye is wounded, especially in the neighbourhood of the ciliary region, or a foreign body becomes lodged within the globe, the injury is apt to be followed by a train of symptoms in the other eye. The wounded eye is then known as the *exciting* eye, whilst the other is termed the *sympathising* eye.

The symptoms present two great varieties, between which it is highly important to differentiate—

1. A series of functional symptoms known as **Sympathetic Irritation**.

2. An organic disease consisting in a plastic and destructive inflammation of the uveal tract, termed **Sympathetic Ophthalmitis**.

It was formerly customary to class sympathetic irritation and sympathetic ophthalmitis together, the former being held to be a mild variety of the latter; but further experience has shown that the two are not necessarily interdependent, and that sympathetic irritation may exist for months, or even years, without being followed by any signs of organic disease; whilst sympathetic ophthalmitis often comes on without any previous sign of irritation. At the same time, it is to be remembered that the conditions which may give rise to the one are similar to those causing the other; so that symptoms of sympathetic irritation, though not of serious import in themselves, must be regarded by the surgeon with anxiety, as indicative of the possible advent of organic disease.

SYMPATHETIC IRRITATION.—The most generally accepted view of sympathetic irritation is that it is a reflex neurosis exhibited in the sound eye, and initiated by an irritative lesion of the ciliary nerves of the wounded eye. The first attack may come on at any time after the primary injury, sometimes occurring within a few days, and in other cases being manifested for the first time during an attack of inflammation in an eye long lost, perhaps for many years. The symptoms of irritation are moreover apt to be repeated from time to time, with each fresh bout of inflammation in the lost or injured eye.

There is a slight indistinctness of vision, objects seem to dance

about, and reading tires the eye. The patient may be able to read No. 1 of Jaeger, and to see distant figures rightly, but he cannot do so for any length of time; the effort of accommodation soon fails, and the eye becomes fagged. During the attack the eye is slightly reddened, watery, and irritable; occasionally it is painful—the patient has neuralgic shootings in it, and this may then be the symptom which gives the greatest trouble. The attack generally lasts for some days, or it may even continue for one or two weeks, and then gradually cease; the recovery being frequently coincident with the cessation of the irritation in the injured eye.

The points in which sympathetic irritation differ from sympathetic ophthalmitis are—

1. Although the eye may be subjected to frequent recurrences of the attacks, yet no fibrinous effusions nor disorganising changes of its different tissues take place.

2. The excision of the lost or injured eye at once arrests the disease. All sympathetic irritation ceases when the cause which gave rise to it is removed.

SYMPATHETIC OPHTHALMITIS.—Sympathetic ophthalmitis consists in an inflammation of the uveal tract, which is essentially of an adhesive or fibrinous character, and which never passes on to suppuration. Its tendency is to rapid plastic effusions, which soon become organised and incapable of absorption, blending the different tissues together, impairing their textures, and destroying their functions. The eye is generally attacked by the disease *without having pain* as a warning. The inflammation often creeps on unheeded by the patient, and frequently the first symptom which draws attention to the apparently sound eye is a slight defect in its ability to define clearly and a general pinkiness of the globe. In children we have seen the disease thoroughly established before they have been brought for advice, simply from the fact that the absence of pain induced the parents to think lightly of the affection. When once fairly started, sympathetic ophthalmitis is very difficult to subdue, and even when arrested *it is liable to frequent recurrence*.

The peculiar tendency of this sympathetic inflammation to cause rapid effusion of lymph is manifested from an early stage of the disease. The lymph is not deposited on the surface in nodules, as in syphilitic iritis, but it occurs as an infiltration, invading the very texture of the iris, ciliary processes, and choroid. In the synechiæ which are formed, it is not simply the pupillary margin, but the whole posterior surface of the iris which contracts adhesions to the capsule of the lens, so that if, at a future period, an attempt be made to form an artificial pupil by tearing away a portion of the iris, the exposed part of the lens capsule will be found covered with uveal pigment, indicating the extent of adhesion which had existed between it and the posterior surface of the iris.

Early in the disease, when the iris is saturated with lymph, it is soft and rotten; but at a later date, when all the acute symptoms have passed away, the iris becomes completely changed in its texture: it is excessively tough, has lost all its elasticity, and is converted into a dense fibrous membrane.

Ætiology.—1. Perforating wounds of the eye, and especially those which involve the ciliary region, or that part which extends for about one eighth of an inch backwards from around the cornea, a space in which lie the ciliary muscle and ciliary processes; and wounds near the margin of the cornea in which there is an entanglement of iris. Wounds of this, the so-called *dangerous zone*, mean injury to the most functionally active and vascular portion of the eye, and are always followed by a severe reactionary inflammation, which serves as the starting-point of the mischief in the sympathising eye.

2. The lodgment of foreign bodies within the globe, particularly those which have caused contused and lacerated wounds. In such cases the ciliary region is frequently involved in the wound.

3. A few cases have been reported in which sympathetic ophthalmitis occurred from other causes than a penetrating wound; and intra-ocular tumours especially have been mentioned in this respect; but in the light of our present knowledge, these cases must be considered doubtful, and are probably to be explained in some other way.

Sympathetic ophthalmitis is seldom if ever excited by a suppurative inflammation of one eye. This fact was noticed by the late von Graefe, and the experience of most observers accords with it. If, however, a foreign body is within the globe, suppuration does not lessen the danger which its presence in the stump will keep up.

The age of the patient has a remarkable influence on this disease—the young are much more prone to it than the old, and it runs its course more rapidly in the child or the young adult than it does in the middle-aged or the old.

The Period at which Sympathetic Ophthalmitis may occur after an Injury.—The onset is probably never earlier than fourteen days after the injury, and most commonly the first symptoms are not seen until about the fifth or sixth week. It is, however, impossible to assign any date at which sympathetic ophthalmitis may be expected, or after which the sound eye may be considered as safe. So long as the irritation primarily excited by the injury continues, the sound eye may sympathise. The risk cannot be said to have passed away until the injured eye has quite recovered; the sclerotic must have regained its normal whiteness, and all photophobia and lacrymation have ceased.

If the injury is from a foreign body within the eye, the sound eye may become sympathetically affected at any time, and after the lapse of any number of years.

Pathology.—*The exact nature of sympathetic ophthalmitis is still a matter of controversy.* For many years it was generally believed that, as its name implies, the disease was due to a reflex or sympathetic inflammation set up in the ciliary nerves of the exciting eye by a traumatic irido-cyclitis, and differing only in the intensity of its symptoms from sympathetic irritation. In 1882, however, Deutschmann's publication of his researches completely revolutionised opinion. The latter claimed to have induced sympathetic ophthalmitis in rabbits by the direct inoculation of pyogenic organisms into the other eye, and to have located the route by which the infection was carried by discovering the bacteria in the chiasma and both optic nerves. Unfortunately nearly

all observers have since entirely failed to confirm Deutschmann's experiments, and have not only *not* succeeded in inducing the disease in animals by any method, but have, for the most part, failed in discovering any constant micro-organisms in human eyes that have been removed after the onset of sympathetic ophthalmitis in the other. Deutschmann's theories were at once, and are still, widely accepted; but though it seems highly probable that in some way a bacterial infection is the causal factor of the disease, and such a theory is in accord with our present knowledge of other forms of metastatic inflammation, still it must be confessed that there are certain facts which are at present not satisfactorily explained by such a theory, and that in the almost complete absence of confirmatory evidence Deutschmann's results must be accepted with reservation.

The present position is best summed up by stating shortly the arguments (1) in favour of a bacterial origin, and (2) the objections to this theory, coupled with the answers with which such objections can be met.

1. Arguments in favour of a specific origin :

a. The disease is almost invariably, if not always, the sequel of *penetrating* wounds alone.

b. In many other forms of metastatic inflammation, a specific virus has been definitely ascertained.

c. The symptoms of sympathetic ophthalmitis may be due to a *toxæmia* without the actual migration of bacteria.

d. With the constantly increasing knowledge of the pathology of disease, a bacterial infection must be considered as the only satisfactory solution.

2. Arguments against a specific origin :

a. Suppurative panophthalmitis never excites sympathetic ophthalmitis. The best answer is that the intensity of the inflammation probably blocks the route by which the bacteria or their products could be carried (Gifford).

b. Why is not meningitis ever produced by the bacteria in the course of their transmission across the chiasma? No satisfactory answer can be made to this objection at present.

c. Sympathetic ophthalmitis may not be manifested for several years after the injury to the exciting eye. This, also, is a difficult point; but, as an analogous case, we sometimes have in tuberculosis an example of a lengthy dormant period before the onset of active disease.

d. Sympathetic ophthalmitis has been recorded in a few cases as having occurred without a penetrating wound. These cases are so rare that it is possible to cast some doubt on the history, and to question whether some forgotten injury might not have been the cause of the symptoms. It has also been urged that such cases are possibly examples of "*endo-infection*."

e. The general failure to confirm Deutschmann's experiments or locate a specific organism. Several answers can be made to this objection :

1. Animals may be immune to sympathetic ophthalmitis.

2. The same difficulties have been encountered in other diseases, such as trachoma and syphilis, which almost certainly have a specific origin.

3. Present limitations in knowledge of methods of growth, or staining, etc., may have prevented the recognition of a constant organism.

4. As has been suggested in trachoma, there may be no regular specific organism ; but the disease may be due to a *mixed infection*.

5. As above mentioned, the disease may be due to a toxæmia without any general migration of organisms, which would render their discovery difficult except at the site of infection.

Finally, it is to be remembered that but little weight can be attached to the *occasional* discovery of micro-organisms in exciting eyes. The mere fact of the presence of bacteria is no proof of their specific character ; the latter, as laid down by Koch, can only be proved by the *invariable presence* of such organisms in all cases, and by their power of reproducing the disease.

Symptoms.—In the **first stage** of the attack the eye is irritable and abnormally sensitive to light ; there is some lacrymation, and the conjunctiva is a little injected ; there are brown spotty deposits on the inner surface of the cornea (*keratitis punctata*), sometimes only to be detected by looking at the cornea with a lens ; and the pupil is decidedly sluggish in its action. The vitreous is clouded by fine opacities, and if not too much obscured, some swelling of the papilla and surrounding retina (neuro-retinitis) will generally be seen. The power of focussing the eye for near objects is diminished, and the patient is unable to maintain a prolonged accommodative effort, so that reading quickly induces fatigue, the words becoming confused, blurred, and at last indistinguishable. At this stage of the disease there is generally *no pain*, not even sufficient to draw marked attention to the eye.

In the **second stage** of the disease, which may rapidly follow the primary symptoms, fibrinous exudations take place within the eye, and lymph is effused in large quantities as an infiltration into the different tissues involved in the inflammation ; the pupillary area of the capsule of the lens is covered, and the iris almost soaked with it. This exudation rapidly becomes organised, and contracts firm adhesions between the whole posterior surface of the iris and the lens capsule. If atropine be dropped into the eye, the pupil is either not affected by it, or it only dilates irregularly and incompletely. The aqueous becomes serous, and the striation of the iris, at first indistinct, is afterwards completely lost.

The **third stage** of the disease is characterised by increased tension of the globe, and this condition is *generally associated with pain*, oftentimes very severe, and sufficient to make the patient willing to submit to any means suggested for his relief. The increase of tension may come on at any time after the inflammatory exudations within the eye

have commenced, and may continue during many months, or even last beyond a year. If the disease runs on, the vitreous atrophies, loses consistence, and diminishes in bulk; and with these changes the increase of tension subsides, and the eye gradually becomes softer than normal, and sinks to -T 2 or 3. As the atrophy of the vitreous proceeds, the retina is deprived of its normal support, and falling forward, becomes partly or completely detached.

The increased tension of the eye, combined with the inflammatory changes in the ciliary region, sometimes lead to a thinning of the sclerotic around the cornea, and to ciliary staphyloma. We have seen several such cases, and they have generally been painful eyes.

Prognosis.—Once the disease has become firmly established, it always proves very intractable, and very frequently, as above described, completely destroys the sight. But there are cases which, seen at the first onset and placed under prolonged and judicious treatment, run a less severe course, and in which the disease remains chiefly confined to the iris and ciliary body, the eye ultimately recovering with damaged but useful sight. Bearing in mind the liability of sympathetic ophthalmitis to relapse, no case must be considered safe until many months have elapsed after the complete subsidence of inflammatory symptoms.

Treatment.—In the treatment of sympathetic inflammation of the eye, we must consider—

1. How to arrest the progress of the disease.
2. How to proceed when the injured eye still retains some useful sight.
3. The general constitutional and local treatment in each of the three stages of the affection.

1. How to arrest the Progress of the Disease.—If the sympathetic inflammation of one eye is dependent on injury to the other, and it is clear that the wounded eye is irreparably blind, or if the exciting cause of the mischief proceeds from a previously lost eye becoming inflamed, then there cannot be a moment's hesitation about the propriety of at once extirpating the injured or the diseased eye.

The importance of removing at an early period an eye which has been so injured as to be useless, and which is exciting or is likely to excite irritation in the other, or the inflamed remnant of a lost eye which is acting as an irritant, cannot be exaggerated; for though *in the very early stage* of sympathetic ophthalmitis the removal of the cause of irritation will frequently induce its subsidence, yet when the disease has thoroughly taken hold of the sound eye, even the removal of the lost one will rarely arrest its progress. There can be little doubt that if an injured eye be excised before symptoms of *irritation* occur in the other eye, then the sound eye is safe from sympathetic ophthalmitis. There may be exceptions to this rule, but they are very few.

2. How to proceed if the Injured Eye still retains some Useful Sight.—On several occasions we have seen the sound eye destroyed by sympathetic ophthalmitis, while the injured eye has ultimately so far recovered that useful sight has been restored to it, and the patient has been able to get about without assistance. As the removal of the

injured eye will probably not arrest the disease in the other, especially if plastic exudations have already commenced, we are of opinion that if sympathetic ophthalmitis be established, the injured eye should not be removed if it retains any useful sight.

3. **General Constitutional and Local Treatment.**—In the *early stage* of the disease, absolute rest to the eyes is imperatively demanded; all reading, writing, or fine work of any kind must be forbidden; when at home, the room should be kept darkened, and when out, dark neutral-tinted protectors should be worn. It is impossible to over-rate the importance of keeping the patient for a long period in a very subdued light; it affords the best hope of success, and places the eyes in a position to receive most favourably the influence of any other treatment which may be adopted. However well the patient may progress, the order to rest the eyes and abstain from work should not be rescinded for at least six to eight months. The disease is very recurrent in its nature, and by exposing the eyes too soon to the stimulus of strong light the chances of relapse will be increased.

During this stage, mercurial inunction into the temple with the Unguent. Hydrarg., either alone or combined with Belladonna (F. 63), may be tried every night, and continued for two or three months, care being taken to avoid salivation by diminishing or omitting the inunction for a few days, as required. The patient should be well fed, as the disease is very depressing, and quinine in 1- or 2-grain doses, according to the age of the patient, combined with extract of belladonna, or bark with belladonna, should be given. From the use of iodide of potassium and perchloride of mercury, both of them favourite medicines in the treatment of exudative inflammations, we have never known the slightest benefit.

Local Applications.—A solution of atropine (F. 10) may be dropped into the eye three or four times a day, and the belladonna lotion (F. 41) may be frequently used. In the later stages of the disease, when the whole posterior surface of the iris is adherent to the capsule of the lens, mydriatics are useless, and only tend to favour the development of the state of increased tension which usually comes on at this period.

In the *second stage* of the disease, when the union between the iris and lens capsule has been effected, but after the acute symptoms have subsided and the eye is quiet, it is a question whether an operation may be attempted to improve the sight. With regard to this point, it may be stated that if the sight is sufficient for immediate requirements, and will enable the patient to walk about without assistance, the eye should be left alone. It is the only eye, and operations on eyes sympathetically inflamed are so unfavourable that it is better to let the patient enjoy the sight he has, rather than to risk the loss of it with the prospect of only a slight improvement.

If, however, the sight is so defective as to be almost useless, and there is a fair field of vision, then an attempt should be made to improve it by an operation, *but no operation should be performed whilst the eye is inflamed.* The objects to be attained are the formation of a new pupil and the extraction of the lens. There are very few

eyes which have suffered from sympathetic ophthalmitis in which an artificial pupil can be satisfactorily made without at the same time removing the lens. The iris has become so changed in structure, and so adherent to the lens capsule, that it is difficult and often impossible to perform an iridectomy; and even when this can be accomplished, it usually fails to benefit the sight, from the exposed capsule of the lens being coated with adherent uvea.

It is therefore generally advisable to endeavour to remove a portion of iris and to extract the lens in the one operation:—First make a section at the corneo-scleral margin, as in the extraction of senile cataract (*see* page 271), and using a *narrow* Graefe's cataract knife; then, if possible, remove a portion of iris; but failing to accomplish this, tear open the pupil and the capsule of the lens with a cystotome; or, if this be insufficient, remove a portion of iris and the adherent lens capsule with a pair of iris scissors; and lastly, with a little pressure on the globe with the back of the curette, cause the escape of the lens through the corneal wound. This operation may generally be accomplished without the loss of any vitreous, and the eye will usually recover from its effects well, but the pupil will probably again become closed. Another operation will afterwards be required for the formation of a new pupil. (*See* "Iridotomy.")

Another method of removing the lens is one proposed originally by the late Mr. Critchett, and which he performed several times with success. Critchett's method is to cause absorption of the lens by successive needlings, several weeks being allowed to elapse between each operation, to allow any reactionary inflammation to subside. Two needles are employed at each operation, so as to lessen the drag upon the ciliary processes, and several needlings will probably be required. (*See also* "Linear Extraction of Cataract.")

The extraction of the lens seems to exert a beneficial influence on the eye, as after it has recovered from the effects of the operation it is much less disposed than it was before to a recurrence of the inflammation.

In the **third** stage of the disease, when there is increased tension of the eye, active treatment is *necessary*. If the state of tension be long continued, the little sight that is left soon vanishes; and relief also is required for the pain which so frequently accompanies the tension. The best treatment if the pupil is occluded is to tear open the pupil and extract the lens at one sitting, as above detailed. If, however, the pupil is fairly clear, the operation of sclerotomy, as being less severe, is to be preferred, and we have performed it in several cases with good results. When increased tension still persists after extraction of the lens a sclerotomy will offer the best chance of saving the eye. (*See also* "Sclerotomy.")

CHAPTER XVI.

GLAUCOMA.

GLAUCOMA is a disease due to a loss of balance between the secretion and the excretion of the intra-ocular fluids, and characterised by an increase in the tension of the globe, impairment of the field of vision, and a progressive failure of sight.

Glaucoma may be classified as follows:

1. Primary Glaucoma.

a. Inflammatory { acute.
 subacute.

b. Chronic or simple non-inflammatory.

2. Secondary Glaucoma, which is a result of pre-existing disease.

3. Congenital Glaucoma or Buphthalmos.

1. General Pathology and Ætiology of Glaucoma.—*The Nutritional Intra-ocular Fluid.*—In the normal healthy eye a fluid, termed the intra-ocular fluid, is being constantly secreted, and as constantly excreted. This fluid serves to replenish the supply of aqueous, and probably also partly nourishes the cornea, lens, and vitreous. Though evidence for long pointed strongly to the ciliary processes as the source of this secretion, their numerous plications being admirably adapted to form a large secreting area, yet the absence of any obvious glands made the matter mysterious, until Collins,* by bleaching the uveal pigment lining the ciliary processes, demonstrated the presence of numerous gland-like involutions or downgrowths of the pigment epithelium, which he termed the “*ciliary glands*,” and which are now generally accepted to be the source of the secretion.

From the ciliary processes the greater portion of the fluid passes into the anterior chamber, through which it circulates, and thence, filtering through the ligamentum pectinatum and the spaces of Fontana, situated in the angle of the anterior chamber (*see* Fig. 104, *l. s.*), it ultimately passes into the canal of Schlemm, and so into the anterior ciliary veins and the general circulation. There are also other lymph-

*Trans. Ophth. Soc. U. K., 1891, vol. ii, p. 55.

paths within the eye by which the nutrient fluid can escape, notably the perichoroidal space between the choroid and sclerotic, and the canal of Stilling in the vitreous chamber, both of which empty posteriorly into the lymph-channels of the optic nerve-sheaths; but for the internal economy of the eye the anterior lymph circulation through

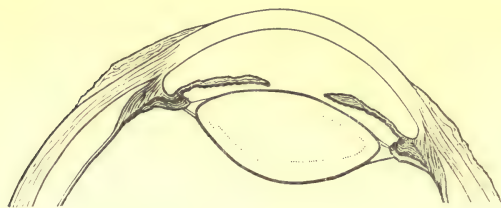


FIG. 118.—The anterior chamber in health. The filtration angle is widely open. (After Priestley Smith.)

the anterior chamber is by far the most important, and it is chiefly, at any rate, owing to obstruction in these paths that glaucoma is due.

As long ago as 1855 von Graefe urged that the symptoms presented by glaucoma were wholly due to the pressure caused by an excess of the intra-ocular fluids. Such an excess might be the result of an increased secretion, or, on the other hand, of a diminished outflow; and as at that time, and for many years later, the circulation of the intra-ocular fluid was not properly understood, and the only recognised form of glaucoma was the acute inflammatory form, it was for long a generally accepted belief that an inflammatory *hypersecretion* was the primary factor in the production of the glaucomatous symptoms.

The next important light upon the subject was Leber's* discovery in 1873 of the communication existing between Schlemm's canal, the spaces of Fontana, and the angle of the anterior chamber; by which direct proof of the intra-ocular lymph circulation was established.

This was followed shortly by the researches of Knies† and Weber,† who showed that in glaucoma this communication was closed by apposition of the root of the iris to the back of the cornea; so that the angle of the anterior chamber was abolished, and the intra-ocular fluid could no longer escape. This was direct evidence in favour of the pressure symptoms being due to *retained secretion*, and it further explained



FIG. 119.—The anterior chamber in glaucoma. The filtration angle is closed by the apposition of the root of the iris to the back of the cornea. (After Priestley Smith.)

at once how symptoms were relieved by the performance of an iridectomy, *viz.* by opening up an exit for the pent-up fluid. Von Graefe originally discovered this means of treating glaucoma, and thereby earned the gratitude of all future generations; but the discovery

was more or less accidental, and in ignorance of its method of cure. The researches of numerous writers have fully confirmed the blocking of the angle of the anterior chamber in all cases and forms of glaucoma, and the absence of any evidence of a primary hypersecretion

* Von Graefe's 'Arch.,' xix, ii, 87.

† Ibid., xxii, iii, 163, and xxiii, i, 1.

renders it more than probable that *retention* is the main cause of the symptoms.

2. Circumstances influencing the Retention of the Intra-ocular Fluid.—Assuming, therefore, that retention is the main feature of glaucoma, what are the causes that lead to this obstruction? and how is it that a similar obstruction causes such disparity in the character of the symptoms, such as we observe between the acute and chronic forms of the disease?

As regards the former point, we always have in secondary glaucoma direct evidence of a *mechanical obstruction*, the result of previous disease. On the other hand, as there is no such pre-existing disease in primary glaucoma, it is necessary to look elsewhere to explain the obstruction, and it is found that patients who suffer from primary glaucoma are the subjects of certain anatomical changes which tend to narrow the angle of the anterior chamber.

Age.—Primary glaucoma rarely occurs before the age of forty, though there are exceptional instances in which the onset has been at a much earlier date. Priestley Smith * has shown that the lens does not cease to grow with the cessation of growth in the rest of the globe, but is always gradually increasing in size, with the consequence that the space between its margin or equator and the ciliary processes (*the circumlental space*), through which the fluid passes into the anterior chamber, is as constantly decreasing; whilst at the same time the iris is ever being pushed forwards from the same cause, so that the anterior chamber becomes shallower and its angle more narrow with advancing age.

Refraction.—Primary glaucoma occurs with especial frequency in highly hypermetropic eyes with small corneæ, or, in other words, in eyes which are smaller than normal; and the liability seems to increase with the amount of deformity in this respect, so that microphthalmic eyes are peculiarly susceptible. Priestley Smith has pointed out that the reason of this lies in the fact that the lens is not appreciably smaller in these than in emmetropic eyes, so that the circumlental space is narrowed by the presence of a full-sized lens in an unduly small and flattened globe. In addition, the anterior chamber in highly hypermetropic eyes is shallowed by the presence of a large hypertrophied ciliary body, which bulges the iris forwards, and tends to further narrow the circumlental space.

As regards the second point, *viz.* the disparity in the symptoms between the acute and chronic forms of glaucoma, the acuteness of symptoms will depend upon the progress of the obstruction, especially as regards its rapidity and completeness. Progression is a constant and marked feature in all forms of glaucoma, and, given an angle sufficiently narrowed by pre-existing disease or anatomical changes to interfere with the due circulation of the intra-ocular fluid, it is, in all cases, only a matter of time before the retention of the fluid is sufficiently great to give rise to the symptoms which we associate with glaucoma. If nothing special happens to *suddenly* increase a partial

* 'Trans. Ophth. Soc. U. K.,' vol. iii, p. 79.

obstruction, the evil effects of retention may be slow in declaring themselves. The circulation is still carried on, though with increasing difficulty; the iris is driven more and more towards the cornea by increasing pressure, and, in course of time, a slowly progressive group of symptoms typical of the *chronic* variety of glaucoma appear. But supposing, on the other hand, that from some cause or another congestion is set up in the already narrowed channels, the obstruction may suddenly become complete, with the result that symptoms of violent inflammation and irritation speedily show themselves, and this is what happens in *acute* glaucoma. The sudden raising of the intra-ocular pressure increases the congestion, to be followed in its turn by a serous exudation from the venous channels, with a consequent further increase of pressure; and thus a vicious circle is quickly established, with symptoms of ever-increasing violence.

The immediate cause of such congestion is often difficult to determine; but, speaking generally, any condition of mind or body that is liable to react upon the general health may determine the onset of acute glaucoma in eyes already predisposed. Mental disturbances seem to possess a special influence, such as the prostration following excessive or prolonged fatigue, anxiety, or the shock of the death of near relatives, or of a heavy pecuniary loss, etc. In such cases the mental shock may, through the vaso-motor nerves, cause a sudden increase in the intra-ocular blood-pressure, with a consequent congestion of the venous channels.

In one case that came under our notice a sudden fright seemed to determine the onset of the symptoms. The patient, a nurse, had from sheer fatigue fallen asleep by the bedside of a patient, when she was suddenly awakened in the night by the snapping of the sash cord and the falling of the window. Within a few hours she had an attack of acute glaucoma.

It may be for the reason that the vaso-motor system is more easily disturbed in women than in men that glaucoma occurs with rather greater frequency in the former than in the latter.

The premonitory symptoms of glaucoma are—

1. **Rapidly increasing presbyopia**, the patient finding it necessary to frequently change his convex glasses for stronger ones, on account of his defect of sight increasing.

2. **Periodic obscurations**, sudden dimness, varying in degree, and lasting from a few minutes to several hours.

3. **Halos or rainbows** around the candle or any other light is a frequent symptom, and one which generally draws the patient's attention to his eye.

4. **Diminution of the field of vision**, and **fading sight**.

5. A gradual **increasing hardness of the globe**.

Such are the warning symptoms of glaucoma, but they may all be so slight, or may make their appearances so slowly, that they may be unheeded, and this is especially the case if one eye only is affected.

PRIMARY GLAUCOMA.

I. ACUTE INFLAMMATORY GLAUCOMA.—This is generally sudden in its attack, occurring usually in eyes which have had premonitory symptoms, though they may not have been appreciated by the patient ; or it may supervene on the simple form of the disease—the chronic glaucoma rapidly and suddenly assuming the acute inflammatory type.

Symptoms.—The eye exhibits all the external manifestations of great internal congestion and acute inflammatory action. There is distension of the ciliary vessels, both of the veins which emerge through the sclerotic in front of the insertion of the recti and of the zone of arteries around the cornea ; occasionally there is also chemosis of the conjunctiva. The anterior chamber is diminished in size, sometimes to such a degree as to bring the iris almost into contact with the cornea, which is anæsthetic and hazy or “*steamy*” from oedema. Pressure on the iris paralyses the sphincter, and the pupil is widely dilated and immobile to light. The patient complains of rainbows or halos of bright-coloured light around candles or lamps, which are due to the disturbance in the refraction of the cornea. The field of vision is diminished, or parts of it are obliterated, and central vision is also greatly impaired, and rapidly gets worse ; so that in a few days, or in very acute cases, as in the “*glaucoma fulminans*” of Graefe, in a few hours, vision is reduced to the mere counting of fingers at a short distance from the eye. The tension of the globe is greatly increased, varying from T 1 to T 3 or stony hardness. (For explanation of these symbols *see* page 24.) The pain caused by the pressure on the ciliary nerves is usually most severe, oftentimes of an almost maddening character. There is a sense of aching and tightness of the globe, with pain extending around the orbit, along the side of the head, and down the nose, but the most acute agony is often referred to the back of the head. This is usually accompanied with severe vomiting, so as to give to the symptoms an aspect of a bad bilious attack, for which, indeed, it is unfortunately too often mistaken. If the case is allowed to drift on without treatment, the pain usually disappears with the onset of blindness, though apt to recur again with a fresh glaucomatous attack.

With the ophthalmoscope, the vitreous and cornea may be so turbid as to prevent a view of the fundus ; but if they are sufficiently clear there will be seen pulsation of the retinal arteries, either spontaneous or produced by the slightest pressure on the globe, and a dilated and tortuous condition of the retinal veins. If the tension of the globe has been raised for some time, the optic papilla will be cupped or hollowed out. Both the arterial pulsation and the cupping of the nerve are due to the increased intra-ocular pressure, which, in the former case, causes an intermittent arterial flow by only allowing the distension of the vessels during the systole, and in the latter case converts the flat surface of the papilla into a crater-like depression. Small blood-spots will often be seen scattered at different parts of the retina. They are the result of capillary hæmorrhages, which take place in most cases of

acute glaucoma, and are also sometimes seen in chronic glaucoma. Filmy blood-clots are also often found in the vitreous.

The Characteristics of a Glaucomatous Cup.—The glaucomatous cup (Fig. 120) involves the whole optic disc; its margin is abrupt, sharp, and sometimes excavated, overlapping the cup; and the vessels, as they curl over its edge, appear to be either interrupted or distorted. If the excavation is *deep*, the continuity of the vessels, as they ascend the side of the cup and mount over its edge, seems to be lost, and the vessels look as if they were interrupted or broken in their course; whilst if the cupping of the nerve is *shallow*, the vessels appear bent or distorted as they pass over its edge. The optic disc is encircled by a light-coloured zone. This is caused by the edge of the sclerotic ring shining through a rim of atrophied choroid, and it is best seen in those cases where the excavation is deepest. The central portion of the papilla has often a peculiar bluish-grey tinge, which increases in intensity towards the circumference of the nerve. So deceptive is the appearance of a deeply excavated nerve, that it resembles more the prominence of a sphere than the hollow of a cup.

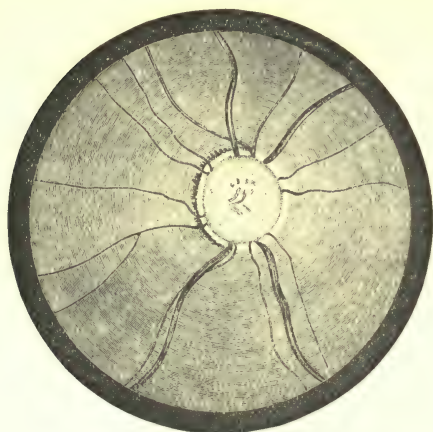


FIG. 120.—Cupping of the optic disc in glaucoma. (See Text.) (For sectional view see Fig. 38, p. 42.)

The depth of a glaucomatous cup may be estimated by the difference in the value of the lenses required to focus the vessels at the summit and base of the cup respectively. A difference of 3 D represents a depth of one millimètre (see "Ophthalmoscope," page 39).

The glaucomatous cup must not be confused with either the physiological cup or the shallow cupping met with in atrophy. For the sake of clearness, the

characteristics of these two forms of cups are mentioned here, though also described elsewhere (see page 42 and Fig. 38).

The physiological cup is simply a shallow depression confined to the centre of the optic disc, in the site where the retinal vessels pass; it looks white and glistening, and its sides are usually bevelled or sloping; it varies greatly in size, but it is surrounded by healthy-looking nerve-structure; it is congenital, and has no unfavourable omen.

The atrophic cup is a slight shelving involving the whole disc surface, and due to shrinking of the nerve-elements in cases of primary atrophy. It causes but little displacement of the vessels, the slight wide curve being quite different from the sharp bend characteristic of glaucoma.

Subacute Inflammatory Glaucoma.—In this form the symptoms resemble those of acute glaucoma except that they are of less intensity.

Results of Acute and Subacute Glaucoma.—The vision may be reduced to a mere perception of large objects in a few days, or, in very acute cases, as in the “*Glaucoma fulminans*” of Graefe, in even a few hours. If the acute symptoms subside, and some of the lost sight is regained, the eye is still left in a very unhealthy and unsatisfactory state. The sight remains impaired, the tension of the globe will generally continue too great, and there is a probability, amounting almost to a certainty, that the eye will sooner or later be subjected to another attack, which will still further damage the sight, if it does not altogether destroy it. After one or more of these acute attacks, the eye will drift into the state of hopeless blindness which has been described as **glaucoma absolutum**. This is, in fact, the last stage of the disease, when the eye is irremediably blind, and when all hope of benefit from treatment has passed. The globe is of stony hardness, the pupil widely dilated, and often irregularly so; the anterior chamber is so shallow that the iris is almost in contact with the cornea, which is anæsthetic and dull in appearance, having lost much of its normal lustre. The humours are turbid, so that the fundus cannot be seen; and it may be that the lens is also cataractous. But, in addition, the eye is often subject to severe pain, which is either constant or so frequently recurring as to destroy sleep and impair health. The suffering may be due either to a repetition of the acute inflammatory attacks, which continue even though the eye is lost, or to the irritation which is excited by degenerative changes taking place in the tissues within the globe.

2. **CHRONIC GLAUCOMA.**—Chronic glaucoma is characterised by the insidiousness of its onset, the absence of inflammation and severe pain, and by the slow but sure progress of the disease. It always ultimately involves both eyes, though it may be, and often is, more advanced in one than in the other. The progress of the disease may extend over several years before blindness is complete, presenting occasional remissions and exacerbations in the symptoms; or from some cause an acute inflammatory attack may supervene, which will completely destroy the sight in a few days.

Symptoms.—The main symptoms of the disease, which are, however, subject to considerable variations, are as follows:—The patient complains of halos or coloured rings of light around bright objects, whilst the eyes feel tired and heavy, and there is often a dull aching pain in the eyeballs or over the brows. At uncertain times and without apparent cause temporary attacks of mistiness (obscurations) will blur the sight. Reading or prolonged use of the eyes produces unaccustomed discomfort, and the reading glasses are not strong enough, and are frequently changed for more powerful ones. A casual examination of the eyes reveals nothing: the sclera is white, and the cornea transparent; but on looking more closely the pupils will be found slightly dilated and sluggish in their reaction to light, and the anterior chamber is decidedly shallow. If we palpate the eyeballs, one or both will be found full to the touch, or the tension may be raised to

T 1 or T 2. The vision may be excellent, and even in advanced cases it is common to find patients reading $\frac{6}{6}$ with perfect ease, and J. 1 with glasses, though we may be struck by the fact that the patient requires unusually strong convex glasses for the latter purpose.

The surgeon must not be led astray by the acuteness of the central vision, but must proceed to the examination of the visual field, which will be found contracted in all cases of long duration. This contraction, which takes place from the periphery towards the centre, may be a general one, but it is always most marked on the inner side,—that is to say, that the nerve-fibres supplying the outer portion of the retina, and which are therefore the longest, are the first to feel the effects of the increased pressure. Thus it frequently happens that the nasal half of the field is reduced almost to the fixation point, whilst vision is still retained over a considerable area elsewhere. In some cases the field may show sector-shaped contractions, but in all cases it is the central or fixation area which is the last invaded, so that patients may retain excellent vision for objects immediately before them, though the scope of their vision resembles that obtained by looking through a small, round tube. The contraction of the field is often evidenced by a complaint on the patient's part that he is constantly stumbling over objects, or that he has to walk with his head down to see where he is stepping. Examination with the ophthalmoscope reveals in all advanced cases turgidity of the retinal veins and glaucomatous cupping of the papilla, which looks grey and atrophic. The colour vision remains good in glaucoma as long as the central vision is not impaired.

Irregular Types.—The disease does not always present the straightforward clinical picture above described. In the early or premonitory stages the symptoms may be exceedingly indefinite, and we must then be content to watch for any progress to confirm the diagnosis, bearing in mind that the three great symptoms are—(1) increased tension; (2) cupping of the disc; (3) contraction of the field.

In some cases the tension is not constantly increased. There is a form of glaucoma, known as "**Intermittent Glaucoma**," in which the symptoms, after lasting for a variable time, are followed by a distinct period of intermission of symptoms, which is closed in its turn by a fresh recurrence, and so on. If the patient is seen during the time of remission, the case may be somewhat obscure, but there will probably be definite cupping of the papilla; and if the field of vision be carefully taken, it will generally be found to be more or less contracted, and this contraction is likely to increase with each recurrence of the glaucoma. In these cases there is usually one of the glaucomatous symptoms specially pronounced, and which forms the predominant feature during the attack. In some patients the prominent symptom is the temporary obscuration of sight, which may vary from great dimness to periods of almost complete darkness; in others there is only an indistinctness of vision, but with marked halos around lights, and with some pain in the eye; in all there is an increase of tension during the attack.

In another class of cases the predominant feature is early atrophy of the optic nerve, which is out of all proportion to the other symptoms.

There is decided increase of tension; but the anterior chamber is of fair depth, and the pupil is but little dilated, though sluggish in its response to the stimulus of light. Ophthalmoscopically there is but slight cupping of the disc; but the latter is very pale, and when the sight is tested there is found to be considerable diminution of central vision with some loss of the general colour-sense. These cases are often characterised by a complete absence of subjective symptoms, halos, obscurations, etc., and in our experience they are the most unfavourable of all cases of chronic glaucoma for active treatment (*see also* "Iridectomy," page 243). They may be described rather as cases of "*Optic Atrophy with Tension*," and they suggest the possibility that a block in the large lymphatic space round the optic nerve, and consequent direct pressure upon the nerve-fibres, may account in part at least for the early onset of atrophy and the unamenability of these cases to treatment.

THE TREATMENT OF PRIMARY GLAUCOMA.—This is either (1) **operative and remedial** or (2) **palliative**.

Operative Treatment.—Operative measures have for their object the restoration of the angle of the anterior chamber and the re-establishment of the intra-ocular circulation. This is effected either by an iridectomy or by sclerotomy. For reasons mentioned in dealing with sclerotomy, iridectomy is the operation upon which the surgeon relies, sclerotomy being reserved for special cases only.

1. **Iridectomy.**—The operation of iridectomy has been generally described on page 221; but when performed for the relief of glaucoma, there are special details to which attention must be paid.

1. A general anæsthetic is required for acute cases, and, unless contra-indicated, chloroform is to be preferred to ether, which increases congestion, and consequently the liability to hæmorrhage.

2. The iridectomy should as a rule be made upwards, so that the drooping of the upper lid may partially conceal the coloboma and lessen the dazzling produced by it. An exception to this rule should, however, be made when the iris is seen to be particularly drawn up and narrow in this situation. This indicates that the adhesions are here especially broad, and some other site should therefore be chosen.

3. The section should be peripheral,—that is, it should extend well back towards the angle of the chamber, so that the iris may be seized and detached as near as possible to its root. The section, which is best made with a Graefe's knife, should commence 1 mm. outside the apparent corneo-scleral margin, the counter-puncture being at a corresponding point on the other side; whilst the dome of the flap should be from 2 mm. to 3 mm. in height, and should similarly extend 1 mm. beyond the apparent sclero-corneal junction.

4. The section should be made very slowly, so as to let the aqueous dribble away instead of escaping with a rush. By this means there is much less danger of the relief of intra-ocular pressure being followed by severe or dangerous hæmorrhage.

5. The iris should be drawn well out, snipped at one end of the wound, then *torn* across the whole width of the wound, and finally

severed by another snip of the scissors, taking care to drag the iris well away from the angle of the wound before cutting it.

6. The coloboma by this method is large, extending right across the wound, and the iris is separated as near as possible to its root.

After-treatment.—The anterior chamber sometimes does not re-form for several days. When this is the case a firm bandage must be kept applied until the union is sound. Under ordinary circumstances a bandage may be left off at the end of a week or ten days, and dark glasses substituted.

The Effects of Iridectomy.—The tension in every case is lowered in the first instance by the release of fluid, and in most cases it remains permanently lowered, though often not sinking to normal for some days or even weeks after operation. In a few cases, fortunately rare, the temporary lowering of the tension by the section is followed almost immediately by a return to the former hardness, and the symptoms are thus only temporarily relieved by the operation. To these cases the term **glaucoma malignum** has been applied, and they are possibly due in some instances to a tilting forwards of the lens from the sudden release of pressure. In other rare cases the release of pressure is immediately followed by rupture of some blood-vessel, and the hæmorrhage may be so severe as to extrude the lens and vitreous from the wound, or in less severe cases may irretrievably destroy the sight.

In acute glaucoma the extreme shallowness of the anterior chamber often makes it very difficult to obtain a good large coloboma, but fortunately the mere dragging upon the iris is generally sufficient to tear away the recent adhesions. In chronic glaucoma attention to detail is of greater importance, as the adhesions are firmer. It must be remembered that the operation acts by reopening the angle of the chamber, and not by merely making a cicatrix through which fluids can filter, as was formerly supposed. However, in some cases, when the adhesions of the iris to the back of the cornea have been particularly firm, and the iridectomy has failed to separate or tear them, a successful result may follow by the formation of a **cystoid cicatrix**. In such cases, probably owing, as Collins has pointed out, to the engagement of a portion of iris in the wound, the union is only partial, and a weak scar is left, which bulges under the intra-ocular pressure, and so allows the filtration of fluids through gaps in the cicatrix, which are only covered by thickened subconjunctival tissue.

The Results of Iridectomy in Acute Glaucoma.—These are most brilliant, and the operation should be performed as soon as possible after the acute symptoms have set in. If the iridectomy is performed in good time, the sight may be completely restored; and even in cases in which the vision is reduced to merely hand-movements, much of the lost sight may be regained. When, however, the perception of light is lost, operation is useless, and the case is beyond the reach of surgical skill. By lowering the increased tension, iridectomy also quickly removes the other symptoms; the pain at once disappears, and the inflammation speedily subsides.

The Results of Iridectomy in Chronic Glaucoma.—Here, again, iridectomy offers the best chance of saving the eye, but its results are not so favourable as in the acute form of the disease. If successful, iridectomy arrests the progress of the disease, but at the most only restores a portion of the sight previously lost. More commonly the disease is arrested, but the sight is not improved at all, but rendered slightly worse on account of the dazzling produced by the coloboma. In others the disease is not completely arrested, though greatly checked in its progress; whilst in a few cases the operation is attended with disastrous results, in that the loss of vision proceeds with even greater rapidity. Experience has shown that the success of operation depends very much upon the time when it is performed, and that if it is carried out in the early stages of the disease it is very successful in completely arresting its progress. Everything, in fact, points to early operation, and the sooner iridectomy is performed after contraction of the field has set in, the better are the chances of permanently checking the disease. The slight decrease in vision caused by a coloboma must not be held as a drawback when it is remembered that the glaucoma, if unrelieved, will sooner or later terminate in complete blindness.

Unfortunately, cases not infrequently first come under notice when the field is very contracted, indicating an advanced stage of nerve atrophy. It is these cases that iridectomy often fails to relieve, and not infrequently hastens the progress. It is doubtful if it is advisable to operate if the field is limited to a few degrees beyond the fixation point, as the patient may retain his sight longer without any active treatment. Our own feeling and experience is against operation in such cases; but some surgeons think that it is better to risk all in favour of the chance, slight though it be, of relief.

Again, if the patient be very old and feeble, and the disease very chronic in its progress, good vision may be retained throughout the remainder of life by the use of myotics; and the surgeon must use his discretion as to the advisability of submitting such a case to the ordinary risks and discomforts of an operation.

Lastly, there is a class of cases, already referred to in describing the symptoms of chronic glaucoma, in which optic atrophy is the predominant symptom, and which are, as a rule, marked by the absence of subjective symptoms. It is often difficult to be certain when we have to deal with such cases, but if the surgeon can satisfy himself on the point he should rely on myotics rather than iridectomy. In our experience the absence of subjective symptoms is always an unfavourable omen as regards the chances of success by operative measures.

2. Sclerotomy.—This operation was originated by De Wecker. It has the same object as iridectomy, and consists of an incision into the sclerotic which opens up the angle of the anterior chamber; but the section is only partially completed, and there is no interference with the iris. Its effects are more uncertain than iridectomy, but when it relieves it does so in the same way.

The chief danger in sclerotomy lies in the liability of the iris to prolapse into the wound, and so it is advisable if possible to contract

the pupil by eserine before operation. If prolapse occurs, attempts should be made to gently smooth the iris back into place, and if this fails, it is better to complete the operation as an iridectomy; otherwise there is a possibility of sympathetic ophthalmitis being induced in the other eye, and the formation of a troublesome cystoid cicatrix.

These considerations have resulted in the operation being abandoned by most surgeons in all cases where an iridectomy can be as efficiently and advantageously performed.

Sclerotomy is, however, a most useful alternative operation, and it is especially indicated in the following conditions:

1. *Cases of glaucoma in which a well-performed iridectomy has failed to relieve symptoms, in preference to a second iridectomy.*

2. *In glaucoma occurring in eyes from which the lens has been removed.* In many cases an iridectomy has already been performed at the time of extraction, and if not, an attempt to excise a piece of iris would be almost certainly followed by a loss of vitreous.

3. *In the late stage of sympathetic ophthalmitis, where there is tension and pain.* Here an efficient iridectomy would probably be impossible on account of the firmness of adhesions and the rotten condition of the iris.

4. *In cases of hæmorrhagic glaucoma.* There is with sclerotomy a less risk of inducing fresh hæmorrhage, an accident which might also be followed by expulsion of the lens and vitreous if the section were completed as in iridectomy.

5. *In glaucoma occurring in eyes with a very high degree of myopia.* Glaucoma rarely occurs in high myopia, but in such an occasional case sclerotomy is to be preferred to iridectomy because of the liability of highly myopic eyes to intra-ocular hæmorrhage.

Sclerotomy is performed as follows:

Instruments required:—(1) Speculum (Fig. 130); (2) fixation forceps (Fig. 132); (3) Graefe's knife (Fig. 113). The lids being separated by a spring speculum, and the eye steadied with a pair of forceps, the knife should penetrate the sclerotic very precisely at a distance of one millimètre from the clear cornea, and then, the blade being held perfectly parallel to the plane of the iris, it should be passed very slowly in front of the latter, so that the counter-puncture may fall also exactly at a distance of one millimètre from the internal border of the cornea. If the blade be not held quite parallel with the plane of the iris, there is danger that it may pass through the cornea, and that the sclerotomy may be but half performed; or, if it be directed too deeply, it may come out through the sclerotic at an exaggerated distance from the cornea, may wound the ciliary body, and may provoke troublesome hæmorrhage and irritative symptoms of an alarming kind. The section should be carried on through the sclerotic by slow sawing movements until a flap of 3 mm. in height has been about two thirds completed, when the knife should be slowly withdrawn from the eye.

Mention may be made here of **Posterior Sclerotomy** or **Scleral Puncture**, which has occasionally been practised in cases of glaucoma malignum, and as a preliminary or alternative to iridectomy or sclerotomy in hæmorrhagic glaucoma. A Graefe's knife is pushed

into the sclerotic in the lower quadrant between the insertions of the inferior and external recti muscles and 8 mm. behind the corneo-scleral margin. The point of the knife should be directed towards the centre of the eyeball, and should penetrate to a depth of 5 mm. The knife is then slowly withdrawn, and in doing so some surgeons advise a slight turning movement of the blade, so that a triangular wound is made in the sclerotic instead of a simple linear one. The conjunctiva should be drawn well forwards before puncturing the sclerotic, so that after the withdrawal of the knife it may slide back over the sclerotic wound, and any escape of vitreous will then be subconjunctival.

Palliative Treatment.—This consists (1) in the use of *myotics*, or drugs which contract the pupil, the most powerful being sulphate of eserine, whilst the nitrate of pilocarpine is second in the order of efficiency; (2) general treatment; and (3) treatment by massage.

1. Myotics.—Mode of Action.—In the normal healthy eye the tension of the globe is not appreciably affected by the size of the pupil, but when the angle of the anterior chamber is pathologically narrowed, the contraction or dilatation of the iris is of considerable moment; for the slight increase in space occupied by an iris contracted or folded up into its narrowest limits, as against the extra room afforded when the iris is extended or drawn out to its furthest dimensions, may represent the difference between a complete blockage of the intra-ocular circulation and the presence of a still effective, though narrowed, channel. Thus it will be seen that the instillation of a mydriatic or dilating drug such as atropine into a glaucomatous eye, by increasing the obstruction and so heightening the tension, is a most unfortunate mistake, though still a very common one, especially in acute glaucoma when the disease is mistaken for iritis. The use of myotics, on the other hand, is very frequently followed at once by a reduction in the symptoms, owing to the increased facility offered to the circulation; the tension is appreciably diminished, and in consequence the pain is relieved and the sight improved. The immediate beneficial effects of eserine are most marked in acute cases where there is much congestion, which it relieves; but unfortunately the acuteness of the pressure soon paralyses the iris, and when this has happened eserine ceases to be of any use.

It must be borne in mind that eserine and other myotics, in that they only act upon the iris, are chiefly empirical in their mode of action; and although they are most valuable for the relief of symptoms, yet we can never hope to *cure* the disease by their use.

Eserine in Acute Glaucoma.—When an acute or subacute case is first seen, a drop of eserine (grs. iv ad 3j) may be instilled, and if the pupil responds and the tension is lowered, an iridectomy is performed under more favourable conditions, and with less risk of intra-ocular hæmorrhage; but if the iris fails to respond after one or two instillations at intervals of an hour or so, the iridectomy should be no longer delayed. The great relief afforded in some cases by eserine must not induce the surgeon to abandon operation. An iridectomy completely relieves and cures as well; but if the surgeon ventures to rely on the

continuance of the primary benefits obtained by eserine, he will probably be rudely awakened by a fresh attack of glaucomatous symptoms, which may partially or wholly destroy the sight before he is able to perform an operation. In acute or subacute cases, therefore, eserine must be looked on purely as an *adjunct* to iridectomy, and for this purpose it is often very useful to hold the symptoms in check in cases of emergency, when it is impossible to obtain immediate operative relief.

Eserine in Chronic Glaucoma.—Here its use is less restricted than in acute and subacute cases. In what may be termed the *premonitory* stages of the disease, when the field is still uncontracted and the symptoms are chiefly subjective with some slight increase of tension, eserine is often very useful, and may check the progress of the disease for an indefinite period, extending in some cases over years. But there will come a time when the case begins to go downhill in spite of eserine; or, as sometimes happens, an acute glaucomatous attack suddenly supervenes, so that as long as treatment is being confined to the use of a myotic it behoves the surgeon to keep a careful watch on the patient, and as soon as he notices that the symptoms are getting beyond control, indicated by advancing contraction of the field and marked cupping of the disc or the sudden onset of congestive symptoms, he should no longer hesitate to advise an iridectomy.

As already mentioned in discussing iridectomy, there are a certain number of cases of chronic glaucoma in which, in our opinion, the surgeon is best advised in relying entirely on myotics and treatment of the general health; and, to reiterate these shortly, they consist of cases in which the field is excessively contracted when the case comes under observation, in very old people when the disease is very chronic, and cases where advancing optic atrophy overshadows the other symptoms.

The Dose of Eserine.—When an immediate and powerful effect is needed, as in acute and subacute glaucoma, it is necessary to employ a strong solution (grs. iij to iv ad ʒj); but when the drug is being employed habitually, a good rule is to use the weakest dose that produces the required effect, and frequently a solution of gr. $\frac{1}{2}$ ad ʒj, or even less, is strong enough for the purpose. Strong solutions of eserine are not only painful, probably on account of the forcible dragging upon the iris, but the drug also tends to dilate the vessels, and so favour congestion. These considerations have induced many surgeons to combine cocaine with eserine, the former drug being a local anæsthetic and a constrictor of the vessels, whilst its feeble mydriatic action is easily overcome by the eserine (*see also* "Cocaine," page 192). Personally we have always found the combination of the two drugs very satisfactory, and usually employ them in the proportion of one grain of eserine to five grains of cocaine (F. 17). When only weak solutions of eserine are required, nitrate of pilocarpine (grs. j to ij ad ʒj) may be substituted, and is often preferred by the patient.

2. General Treatment.—It is chiefly in chronic glaucoma that this is important. Refractive errors should be corrected, and in high hypermetropia the patient should be made to wear glasses both for

distant and near vision, so as to relax all accommodative efforts as much as possible. All sources of worry and mental anxiety should be as far as possible removed, and the patient encouraged to lead a quiet, unexcitable life. The maintenance of a sound condition of the general health is of moment, and attention should be therefore paid to the regular action of the bowels and the digestive functions, and examination made for any organic disease which may be interfering with the patient's well-being.

3. **Treatment by Massage.**—This has been frequently tried in cases of chronic glaucoma, and is said to have proved beneficial in lowering the increased intra-ocular tension. Quite recently Messrs. Buckhardt, of Leipzig, have introduced an instrument by which massage can be applied electrically to the globe in the form of vibration massage, but sufficient time has not elapsed to speak decidedly as to the practical value of it.

SECONDARY GLAUCOMA.

Predisposing Causes of Secondary Glaucoma.

1. **Iritis** after the formation of extensive posterior synechiæ. The intra-ocular fluid, thus unable to find a sufficiently ready way into the anterior chamber, accumulates behind the iris and bulges forwards its peripheral portions against the back of the cornea (iris bombé), with the result that the obstruction is completed by blockage of the angle of the anterior chamber.

Treatment.—Iridectomy. Here the iritic adhesions may be a bar to obtaining a satisfactory coloboma; but as we only wish to re-establish communication between the anterior and posterior chambers to effect a cure, a fair-sized rent in the iris may be sufficient to relieve the glaucomatous symptoms.

2. **Serous Irido-cyclitis**, chiefly by the formation of plastic adhesions between the root of the iris and back of the cornea. This may occur in the later stages. In the early exudative stage, there is often increased tension from the pouring out of serous exudation, but the filtration angle is open, and the condition is not, then, a true glaucoma, and would not be benefited by iridectomy.

Treatment.—Iridectomy, as for primary glaucoma.

3. **Sympathetic Ophthalmitis** from the same cause as the preceding, *viz.* the obliteration of the angle of the anterior chamber by plastic exudations.

Treatment.—Sclerotomy or iridectomy. The latter may be impossible, owing to the density of the adhesions and rotten state of the iris.

In all of the preceding conditions glaucoma may also be caused by **total posterior synechia**, in which case the accumulation of fluid behind the lens drives the latter forwards and closes the filtration angle. The *treatment* is almost hopeless; but removal of the lens offers the best chance.

4. **Perforations of the Cornea.**—The iris may be entangled in the

wound, or become adherent throughout to the back of the cornea, thus abolishing the anterior chamber.

Treatment.—Anterior synechiæ may be divided by a small Graefe's knife passed across the chamber, or by Lang's twin knives (Fig. 85). Complete adherence of the iris to the cornea does not admit of treatment, and the eye is hopelessly lost.

5. **Intra-ocular Tumours** may press upon the ciliary body and iris, and obliterate the angle of the chamber either by mechanical pressure or by extension of the growth.

Treatment.—Enucleation is the only treatment.

6. **Intra-ocular Hæmorrhage.**—Hæmorrhage behind the lens, if severe, drives the lens, ciliary body, and iris forwards, and closes the angle of the chamber.

Treatment.—Sclerotomy offers the best chance of relief. Iridectomy would probably be followed by fresh hæmorrhage and possible expulsion of the lens and vitreous.

7. **Incipient Senile Cataract.**—The swelling of the lens sometimes produces glaucomatous symptoms by mechanical pressure.

Treatment.—Preliminary iridectomy.

8. **Traumatic Cataract.**—The exposure of the lens to the action of the aqueous causes rapid swelling, which may speedily induce an acute glaucoma. In the same way, the operation of needling a *lamellar cataract* is often followed by rapid increase of intra-ocular tension.

Treatment.—The swollen lens must be let out by an incision through the cornea.

9. **After Extraction of Senile Cataract,** a piece of lens capsule or fragment of iris may become incarcerated in the wound.

Treatment.—Sclerotomy offers the best chance. It would be very difficult to perform iridectomy, and there would be much danger of loss of vitreous.

10. **Dislocations of the Lens.**—Glaucoma is most apt to be induced in anterior or lateral dislocations.

Treatment.—Removal of the lens.

Blind Glaucomatous Eyes.—Operative interference is seldom of any use as a measure for relieving pain. Such eyes are very liable to acute attacks of pain and inflammation, which are best relieved temporarily by frequent hot fomentations and the application of one or two leeches to the temple. If these attacks frequently recur, the best treatment is excision or evisceration by Mules' method. (For comparison between these operations see page 311.)

CONGENITAL GLAUCOMA—BUPHTHALMOS—*Hydrophthalmia*—*Kerato-globus*.

Glaucoma may be initiated in infancy either as a result of congenital malformation at the angle of the anterior chamber, whereby the root of the iris remains adherent to the cornea (see "Development," page 94), or from inflammation of the iris and ciliary body, and the formation of

adhesions during foetal life or early infancy. Owing to the elasticity of the young tissues, the consequence of the increase in the intra-ocular pressure is a general expansion of the globe, more particularly of the anterior half, which is unsupported by the orbital tissues, and as a result the objective symptoms that characterise glaucoma in adults are largely modified, and the eye presents a picture that has caused the term "*Buphthalmos*" or "*ox-eye*" to be applied to the disease.

Symptoms.—The eye presents a uniform enlargement of the anterior half of the globe, which often attains to such dimensions as to prevent the lids from closing over it. Both eyes are usually affected, although one may be more seriously involved than the other. The peculiar amazed stare which this deformity of the eyes gives to the patient is very unsightly.

Opinions can, however, differ on this latter point. Some little time ago we saw a young married woman, both of whose eyes were very markedly buphthalmic, and who had had the misfortune to dislocate the lens in one eye by striking the eye against the handle of the perambulator. The husband despairingly alluded to the damage that he feared would permanently mar the beauty of her large pathetic eyes.

The *cornea* will sometimes be seen of almost double its normal proportions. In most cases it is slightly cloudy, sometimes it is quite opaque, whilst in others, again, its transparency is unimpaired. The adjacent *sclerotic* is thinned and of a bluish colour, from the subjacent choroid shining through it. The *anterior chamber* is large and deep, and the *iris* is pushed backwards, frequently tremulous, and so greatly stretched that its ciliary attachment is occasionally drawn within the anterior chamber; and in severe cases we have seen large rents in the iris, caused by the separation of its fibres from extreme stretching. The pupil is usually rather dilated and sluggish, and sometimes oval or pear-shaped; but occasionally the pupillary margin is completely adherent to the lens capsule, from the attacks of inflammation to which it has been subjected. The sight is always very defective, and in the worst cases completely destroyed. The disease is usually slowly progressive; but is occasionally arrested with the retention of useful sight, as in the case above related, where the patient was twenty-six years of age and could perform her ordinary daily duties.

Treatment.—Unless the disease is steadily increasing and the sight diminishing, it is best to leave hydrophthalmic eyes alone. Their powers of repair are enfeebled, and they stand operations badly. Certainly an iridectomy does occasionally do good; but, on the other hand, it is likely to do positive harm. In a few cases where the buphthalmos has been clearly associated with congenital syphilis, we have given the pulv. hydrarg. cum cretâ every night for some weeks and obtained a marked diminution of the size of the globe. If one eye is quite blind and suffering from not being fully protected by the lids, it may be excised.

CHAPTER XVII.

DISEASES OF THE LENS.

ANATOMY.—The crystalline lens is a soft body enclosed in a tight elastic membrane known as the *capsule*. The circumference or *equator* is circular, and bounds two convex surfaces, of which the posterior is more highly curved than the anterior. The centre of curvature of each surface is respectively known as the *anterior* and *posterior pole*. Posteriorly the lens is separated from the vitreous by the hyaloid membrane, and lies in a shallow cup-shaped depression known as the *fossa patellaris*. Anteriorly it is in contact over the pupillary area with the iris, but more peripherally it is separated from this structure by a narrow interval—the posterior chamber. The lens is held in position by the *suspensory ligament* or *zonule of Zinn*, which is composed of a series of delicate structureless fibres running from the ciliary processes to the equator of the lens, and dividing just before reaching the latter, to enclose a minute triangular lymph-space known as the *canal of Petit*.

The lens capsule is a homogeneous structure, much thicker anteriorly than posteriorly. Clinically it is usual to speak of an anterior and posterior capsule, but the terms are for convenience only, and the two are parts of the one membrane. The anterior portion of the capsule is lined by a single layer of cubical cells, by the differentiation of which into lens fibres the lens owes its growth subsequent to foetal life.

The lens substance is composed of homogeneous six-sided fibrils, each of which represents the evolution of an epithelial cell. These fibrils are united to each other by a soft, transparent cement substance, and do not severally run across the whole face of the lens, but are collected into wedge-shaped segments arranged in concentric layers with their apices towards the poles; each segment being made up of fibres which bend round the equator so as to be applied to both surfaces of the lens.

If the lens is hardened, its division into these concentric segments can be easily demonstrated, and when “*in situ*” oblique illumination will sometimes reveal a star-shaped figure (*the lens star*) with arms

radiating from the centre to the periphery, and formed by faint greyish lines of cleavage. The picture is most clearly presented in some cases of senile cataract in an early stage, but it is also occasionally to be noted in perfectly healthy lenses.

The lens has one peculiar and important characteristic, originally pointed out by Priestley Smith,* *viz.* that of growing uninterruptedly throughout life. This he has shown to be due to the presence of the capsule, which prevents the exfoliation of the lens superficies, as occurs in other epidermic structures to which the lens is analogous (*see* "Development"). The growth takes place by the superimposition of fresh fibres at the equator, which are derived by a process of elongation from the cells lining the anterior capsule. Thus the lens, which is nearly spherical at birth, becomes gradually less so with advancing years, whilst its transverse diameters slowly increase. Another result of this continual growth is the compression of the more deeply placed fibres, which lose their fluid and become hardened, or *sclerosed*. Thus in quite early life the centre of the lens has already a hard core composed of these sclerosed fibres, and, as growth continues, this central hard area gradually increases in size and density, so that in old people it occupies the greater portion of the lens. In this way the lens substance is early differentiated into a soft superficial portion, or *cortex*, and a hard central area, or *nucleus*. The distinction is one of importance, clinically as well as pathologically, because opaque lenses that have a nucleus of considerable size are not amenable to the same treatment as lenses which are wholly or chiefly composed of cortical material.

The youthful lens barely reflects any light, and by oblique illumination only a faint grey shadow indicates its presence; but when in late life the nucleus is large and dense, it gives out a distinct yellowish reflex, which has been, and often is, mistaken for cataract.

Another effect of these changes in the constitution of the lens is a gradual alteration both in its static and dynamic refraction, which have been already discussed in dealing with presbyopia and accommodation.

CONGENITAL ABNORMALITIES.

CONGENITAL ABSENCE OF THE LENS—*Congenital Aphakia*.—This is exceedingly rare. A very few instances have been observed in blind microphthalmic eyes (Seiler, von Ammon, and Becker), and a case has also been reported by Dunn,† in which the affected eye was apparently of good size, but was, nevertheless, quite blind from other developmental defects.

COLOBOMA OF THE LENS is seen as a notch in the inferior border of the lens. It is probably due to defective or arrested development of the zonule of Zinn at this spot, which is almost invariably opposite the foetal cleft. The loss of elastic traction produces the notched appearance (Gunn, Treacher Collins). Very exceptionally the coloboma is to one side.

* 'Trans. Ophth. Soc. U. K.,' vol. iii, p. 79.

† 'Arch. of Ophthalm.,' 1896, i, p. 112.

CONGENITAL DISPLACEMENT OF THE LENS, or "*ectopia lentis*," is invariably upwards, or upwards with an inclination outwards or inwards. The displacement and its direction are due to congenital absence or weakness of the lower set of the zonular fibres over the region of the fetal cleft, allowing the lens to be drawn upwards by the action of the unopposed superior fibres of the zonule (Collins). The ectopia is sometimes accompanied by a corresponding displacement of the pupil (*corectopia pupillæ*), or by a coloboma of the lens.



FIG. 121.—Congenital displacement of the lens.

As in so many congenital deformities, there is often a family predisposition, and we have seen an instance in two sisters who both had displacements of both lenses with *corectopia*.

LENTICONUS, as its name implies, consists in a cone-shaped projection from the surface of the lens. It is a very rare abnormality, and may affect either the anterior or posterior surface, though the large majority of reported cases have been instances of posterior lenticonus. The condition may be diagnosed by the appearance of a transparent disc like a drop of oil on the anterior or posterior lens surface, over which the refraction is higher than elsewhere. In some cases there has been some accompanying opacity of the lens, but in others it has been quite transparent.

The only case that has come under our personal observation was an anterior lenticonus in a man *æt.* 30 years, and the appearance it produced is accurately represented in Fig. 122. The refraction was myopic over the projection, and slightly hypermetropic elsewhere. The increase in refraction caused an alteration in the picture of the retinal vessels, which, when viewed by the indirect method, appeared to suddenly diminish in size as they crossed behind the projection. The base of the cone was surrounded by a delicate whitish ring of opacity, but elsewhere the lens was quite transparent. On the outer side of the cone was a second much smaller globular patch, which ultimately became opaque, though no material alteration in the main cone occurred during the two years we had the case under observation. The cone was centrally placed, and projected into the anterior chamber, and the vision, which was $\frac{6}{36}$, could not be improved by glasses. The patient came not on account of this eye, but because of a traumatic



FIG. 122.—Anterior lenticonus. Appearance of the cone when viewed by the ophthalmoscope, indirect method. (See Text.)

cataract in the other, and in this one a similar central white ring could be differentiated, as though there had been an anterior projection in this eye as well, though the latter could not be made out.

Practically nothing is known of the pathology of lenticonus, and it is doubtful whether the condition is always a congenital one or not. The appearance is certainly suggestive of its being due to a hernia of the lens. The ring of opacity in the case just described was probably due to some proliferation of the epithelium of the lens at this spot.

CONGENITAL OPACITIES IN THE LENS.—(See “Congenital Cataract.”)

CATARACT.

As the lens is avascular, it cannot, strictly speaking, become inflamed. The result of any interference with its nutrition is manifested by changes which lead to a diminution or loss of its transparency; changes which are collectively grouped together under the name of “cataract.” Thus cataract is a generic term, simply implying an opacity of the lens without reference to the cause. In the great majority of cases the opacity is confined to the lens substance; but in a certain number the capsule is also involved, and the opacity is then defined as a *capsulo-lenticular cataract*.

Cataract may be classified, according to its ætiology, under the following heads:

- a. It may be **congenital**; that is, associated with mal-development.
- b. It may be **infantile**; that is, arising as a complication of disorders peculiar to young life.
- c. It may occur from old age, as one of the results of senile decay, and is then rightly termed “**senile cataract**.”
- d. It may be produced by injury, and it is then called “**traumatic cataract**.”
- e. It may be dependent upon a **constitutional disease** in which the general nutrition of the body fails, as in diabetes.
- f. It may occur as a sequela of inflammatory or degenerative changes in some part of the uveal tract. This class is distinguished as “**secondary cataract**.”
- g. Or it may occur in foetal life or early infancy, as a result of the proliferation of the cells lining the anterior capsule. This variety is known as “**anterior polar** or **pyramidal cataract**,” and is also sometimes classified under the head of **capsular cataract**.

Cataracts are said to be **complete** or **partial**, according as the opacity involves the whole or part of the lens. They are also sometimes classified according to their consistence as **hard**, **soft**, or **fluid** cataracts. A cataract is hard when occurring in a sclerosed lens, so that all cataracts in old people are designated as hard, whilst equally all cataracts in young patients, when the nucleus is not formed or is small, are called soft. Fluid cataracts are hypermature cataracts in which the cortical matter has undergone liquefaction.

Finally, cataracts may be classified clinically according to the situation of the opacity. Thus we speak of cortical cataract, in which all the cortex indifferently is involved; of capsular cataract when the opacity lies just beneath the capsule; and of perinuclear cataract when the opacity is confined to the perinuclear zone of the cortex.

The microscopical changes in a lens that is becoming cataractous consist, firstly, of increase in the watery elements. The soft fibres of the cortex swell up, become granular, and often vacuolated. Interstices filled with fluid appear between the fibres, and the lens increases in bulk, as is shown by the narrowing of the anterior chamber, and also in some cases by a heightened intra-ocular tension. In the second stage the fibres become opaque, and the fluid elements become absorbed, so that the lens returns to its former bulk. In many cases no further changes will occur for years, but in others the cortical material undergoes further degenerative processes, breaking down into a sticky, granular detritus, sometimes of a fatty nature, or more rarely becoming liquefied. The nucleus takes no share in the above changes on account of its hard, resistant nature, and usually remains more or less transparent. In cataracts of long standing the capsule may become opaque by proliferation of its sublying epithelium, or by the deposit of lime salts, which may permeate it and the degenerated lens mass.

The Action of the Aqueous Humour upon the Lens.—If a rent is made in the capsule of the lens, so that the lens substance becomes permeated by the aqueous humour, the proceeding is followed by rapid swelling of the lens fibres, which become opaque, and are ultimately absorbed. The aqueous only acts on the soft cortex of the lens, and is powerless to affect the hard nucleus. We see this action of the aqueous in traumatic cataract, and we take advantage of it to produce absorption of cataracts affecting young people, in whom there is little or no nucleus present.

A. CONGENITAL CATARACTS.

The congenital cataract, as its name implies, comes on during foetal life. Congenital cataracts are usually shrunken, opaque lenses occurring in small, ill-developed eyes. They are almost always bilateral, and are frequently associated with nystagmus or involuntary oscillations of the globe. Other evidence of maldevelopment, such as mental deficiency and stunted bodily growth, not infrequently accompanies this form of cataract, but we have seen patients in which quite the reverse was the case. Another rare form of congenital cataract consists of a collection of *minute dotted opacities*, scattered irregularly through the cortex, but most generally aggregated near the posterior pole. Vision in this variety is not, as a rule, seriously affected, and never sufficiently so to warrant operative interference.

Treatment.—If there is a small, shrunken lens, consisting chiefly of opaque capsule, and with but little lenticular matter, the best plan is to dilate the pupil with atropine, and having made an opening well within the margin of the cornea with a triangular knife or broad needle, to introduce through the wound a pair of iris forceps, and seize the shrunken lens and draw it out. If there should be any prolapse of the iris, it is better to snip it off with a pair of scissors than to return it. The operation is in some cases rendered more difficult by immobility of the iris, which remains in a semi-contracted state, and will not

respond to the influence of atropine. This is not due to adhesions, but to some form of mal-development in the iris itself or its nerve-supply.

If the lens should not be much shrunken, then an operation for solution or linear extraction should be performed (*see* page 258).

An important question is the age at which an operation should be performed. When the cataract is so complete as to prevent the child from seeing surrounding objects, it should be done as soon as possible after three months of age. If, however, the child has sufficient sight to play and run about, then we think it better to wait until the completion of the third year, by which time the eye has attained a fuller growth, and is better fitted for an operation. The object of early operation in the former case is to prevent nystagmus, which frequently does not appear until the child begins to learn fixation, and results then from an inability to properly co-ordinate the eyes, owing to defective sight. (*See also* "Nystagmus.")

B. INFANTILE CATARACT.

The infantile cataract comes on after birth, and occurs in well-developed eyes. It is usually discovered during the early years of infancy, and is frequently associated with infantile convulsions.

There are two kinds of infantile cataract, each of which requires to be specially noticed—the "*lamellar*" and the "*cortical*."

Lamellar, Zonular, or Perinuclear Cataract (Fig. 123).—It is still a vexed question as to whether this form of cataract is *ever* congenital. The weight of evidence, however, goes to show that it occurs in early infancy. It has been clearly shown to have a close connection with rickets and with defects in other epiblastic structures, particularly the skin of the face, which is often coarse and pitted, and the enamel of the teeth, which is almost invariably defective. Mr. Jonathan Hutchinson first drew attention to the latter point. He says, "It is wholly different from that met with in congenital syphilis, and consists not so much in alteration of the form of the teeth as in defective development of the enamel. . . . The incisors, the canines, and the first molars are the teeth which suffer most; and, as a rule, with but very few exceptions indeed, the bicuspid escape entirely. The contrast between the clean, white, smooth enamel of the latter and the rugged, discoloured, spinous surface of the first molar is often very striking. The first molars may indeed be counted as the test teeth as regards this condition; just as the upper central incisors are in that which is due to syphilis. In these teeth it occurs equally in both jaws. They are sometimes affected when all the other teeth escape, and I believe they never escape when the others suffer."*

The cataract presents a peculiar and characteristic appearance.



FIG. 123.—Perinuclear or lamellar cataract.
A. Front view. B. Sectional view.

* 'Brit. Med. Journ.', i, 1875.

Within the lens there is seen a central opacity surrounded by a transparent margin, which may smoothly mark off the opaque area, or may be intersected by radiating jagged striæ known as "*riders*," which spring from the circumference of the opacity. The central zone and the superficial lamellæ of the lens are clear, and between these is a layer of opaque matter, which constitutes the cataract. The opacity has been demonstrated by Lawford, Treacher Collins, and others to consist of vacuolation and degeneration of the perinuclear zone. Viewed by oblique illumination, the opacity is clearly exhibited as a grey area in the centre of the lens, whilst with the ophthalmoscope it shows up as a series of dark radii on a red ground. The density of lamellar cataract varies very considerably, so that in some cases a modified red reflex can be obtained throughout the entire opacity when viewed by the ophthalmoscope, and in other cases the opacity can be seen to be darker at the edge than at the centre, where transparent lens matter of the nuclear zone is interposed. The sight is always more or less dim, and this defect is often attributed to myopia because, in order to increase the size of the retinal images, the child holds his book close to his eyes. The sight is often improved by slight dilatation of the pupil, so that the child may be noticed to read with his back to the light. Lamellar cataract is almost invariably bilateral, and is usually, but not always, stationary. Sometimes it begins to progress after adult life has been reached, and we have operated on several cases for this reason between twenty-five and thirty-five years of age.

The Cortical Infantile Cataract is decidedly rare. The opacity commences in the margin of the lens, and is seen as opaque striæ running from its circumference towards its centre. In the early stage of this form of cataract the intermediate spaces are clear, and through them the fundus of the eye can be examined with the ophthalmoscope; but patches of cloudiness or opaque dots soon appear in different parts of the lens, and these gradually diffuse themselves, and ultimately render the whole opaque.

Treatment of Infantile Cataracts.—The extent of the opacity in lamellar cataract, and the consequent defect in sight, varies very largely in different cases; so that it is impossible to lay down a course of treatment that will suit all cases alike. When the opacity is very small, very useful vision is retained, and it then becomes a question as to the advisability of interfering in any way. Speaking generally, we think that if the child can read $\frac{6}{12}$ ($D = 12$) and Jaeger 4, it is best to leave the eyes alone. If the vision is less than this, either an iridectomy or an operation for the removal of the lens should be undertaken; but it must be borne in mind that treatment is sometimes disappointing, as the eyes are not infrequently amblyopic.

An iridectomy is only indicated when very decided improvement in vision is obtained after dilating the pupil, and the sight should always be tested in this way before advising this method of treatment. As it is only required for visual purposes, the iridectomy should be made as small as possible, and in the situation which experience has shown to be cosmetically the most suitable, *viz.* down and in. The routine of such

an operation is described on page 223. As a rule, visual iridectomies are disappointing in lamellar cataract. It is very difficult to obtain a coloboma which is not so large as to partially defeat its own purpose by causing dazzling and confusion, and in the majority of cases the patient seems to derive but little benefit.

For these reasons, the operation has fallen much into disuse, and the treatment now generally adopted, with much more brilliant results, is the removal of the lens by tearing a rent in its capsule and submitting it to the action of the aqueous humour, under which the lens fibres swell up, become opaque, and then slowly dissolve. This operation is known as "**Discission**" or "**Needling the lens capsule,**" and it may be followed later, at the discretion of the surgeon, by a second operation to remove the swollen and macerated lens. The two operations comprise the first and second stages of the operation known as the "**Linear Extraction of Cataract**" and will be described together. It must be understood that the second stage of linear extraction is not necessary in many cases; but if the lens is left to the solvent action of the aqueous alone, it will be several months before complete absorption has taken place. Very frequently a second or third needling of the lens will be needed. The intervals between each operation must be regulated according to the progress of the case; from three to six months being the time that is usually required, and the patient must be kept under the supervision of the surgeon during the whole period of absorption.

These considerations have led to a very general habit of proceeding with the second stage of linear extraction a few days after the lens has been needled, and when it has come well forward into the anterior chamber. By this means the treatment is considerably expedited; but it has the drawback of involving a rather freer laceration of the lens at the first operation than is otherwise necessary, so as to bring as much of the lens under the influence of the aqueous as possible. It is therefore followed by a greater reaction, and there is a greater danger of iritis. In some cases it is *necessary* to proceed with the second stage of the operation. If the laceration of the lens has been very free, the bulging of the swollen lens matter may induce an attack of secondary glaucoma, which must be relieved by the release of the obstructing matter; or if the first operation be undertaken on a patient over twenty-five, it is probable that there will be a small hard nucleus, incapable of absorption, which requires to be let out by operation.

A third method of dealing with these cataracts is known as the "**Suction Operation.**" A few surgeons still employ it, but the method has nothing to recommend it over linear extraction, and is not to be advised.

Linear Extraction of Cataract.—The operation known as Gibson's, from the late Mr. Gibson, of Manchester, having first suggested and performed it, is now recognised and practised, with some slight modifications, under the name of linear extraction.

Instruments required.—First stage: (1) Speculum (Fig. 130); (2) fixation forceps (Fig. 132); (3) discission needles, one or two (Figs. 138, 139). Second stage: (1) Broad needle (Fig. 107); (2) curette (Fig. 125); (3) speculum; (4) fixation forceps.

It is well adapted to a large majority of the cases of soft cataract, but it is an operation which requires great care and great delicacy of manipulation.

Prior to performing the operation, the pupil should be fully dilated with atropine, so that the whole of the lens may be under the observation of the operator, and the iris may be drawn away as far as possible out of reach of injury.

The operation may be divided into two stages.

First Stage.—The speculum having been introduced and the globe conveniently steadied by fixation forceps, a fine cutting needle is introduced obliquely through the outer margin of the cornea. By making an oblique opening, the aqueous is more easily prevented from escaping during the manipulations of the needle, which is then thrust lightly into the lens substance, and swept across the face of the lens by light movements of the wrist. About two thirds of the lens capsule should be lacerated, and the needle carefully moved through the soft lenticular matter, so as to comminute it and bring every portion in contact with

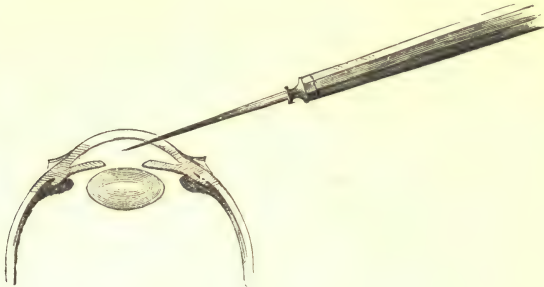


FIG. 124.—The first stage of linear extraction of cataract, showing the method of passing the needle.

the aqueous. A rather less free laceration is needed if it is not intended to proceed with the second stage.

Great care must be taken not to injure the posterior layer of the capsule of the lens, as by so doing the hyaloid membrane would be ruptured, and the vitreous, mixing with the particles of the lens, would materially interfere with the due action of the aqueous humour on them, and also render more difficult the second part of the operation.

The difficulties which may beset this stage of the operation are—

1. The lens-capsule may be so tough that the point of the needle will puncture but not lacerate it, and all attempts to tear an opening will only cause the lens to shift about before the pressure of the needle without making any sufficient rent in the capsule. In such a case two needles should be used. The first needle should be introduced through one side of the cornea into the centre of the lens-capsule, so as to fix the lens, whilst the second needle is passed through the opposite side of the cornea, and made to penetrate the capsule at the same spot at which the first needle entered. The points of the two needles should now be drawn apart, and thus a free opening may be torn in the

capsule without exerting any strain upon the suspensory ligament of the lens.

2. The central portion of the anterior capsule of the lens may be chalky or semi-opaque. When this is the case, the needle which is used to break up the lens substance should, before its withdrawal from the eye, detach the semi-opaque portion or capsule. A free opening should then be made with a broad needle in the cornea at a point corresponding with the pupillary edge, and with a pair of iris forceps the semi-opaque capsule should be seized and drawn out of the eye.

After the operation, the patient should be kept in a darkened room, but not in bed, and a solution of atropine of the strength of gr. iv ad aquæ ʒj should be dropped into the eye twice a day.

The second stage consists in removing the broken-down lens through a small linear opening in the cornea. Before it is attempted, if nothing has happened since the first operation to necessitate its immediate performance, sufficient time should be allowed to elapse for the transparent portions of the lens to become opaque, and somewhat macerated by the aqueous. From three to six days will be about the time required for the desired changes to take place, but much depends on the condition of the cataract at the time of the operation, and upon the extent to which the capsule has been torn, and the lenticular matter broken up.

The pupil being widely dilated with atropine, an opening is to be made in the cornea with a broad needle at a point just external to where the pupillary margin of the iris is seen. Instead of inserting the needle through the cornea directly from before backwards, it should be made to pass obliquely inwards through the lamellæ of the cornea, as is represented in Fig. 124. The aperture thus made will be valve-shaped, the object being that the aqueous shall not escape too rapidly, and that the curette during and after its introduction shall not press at all upon the iris.

A sufficient opening having been made, the curette is next to be introduced, and this should be done with a gentle lateral motion. The eye being still held by the surgeon with a pair of forceps in the most convenient position, the curette is moved gently from side to side, pressing slightly on the mouth of the wound to permit the aqueous with the softened lens to flow down its groove. When the largest portion of the lenticular matter has escaped, small opaque pieces will occasionally be seen which have not flowed away in the stream; these may be followed by the curette, and on the point of it being dipped beneath them, they will also escape along its groove. All the movements of the curette must be conducted with the greatest caution, as it is essential that the posterior capsule should not be broken. When this accident happens, the opaque fragments of lens become entangled in the vitreous, and no further attempt should be made to remove them.

It sometimes happens that a tag of lens capsule follows the with-



FIG. 125.—A silver curette with blunt rounded edges.

drawal of the needle in the first stage of linear extraction, or the curette in the second stage, and becomes adherent to the corneal wound. If noticed at the time, it should, if possible, be replaced free of the wound, as it may serve as a channel for infection; but if this is impossible, it may be divided later on by Lang's twin knives (*see* Fig. 85).

The lens having been removed, or as much of it as will readily flow away, the patient is to be sent to bed in a darkened room, and a light bandage applied to the eye for a week after the operation, when dark glasses may be substituted until all irritation has subsided. The pupil should be kept under the influence of atropine until the process of absorption is completed.

Extraction of Soft Cataract by Suction.—This method of removing a soft cataract was introduced by Pridgin Teale, junr., of Leeds, in 1863.

The extraction of the lens by suction may be completed in one operation, but it is better, as a rule, to divide it into two stages. The **first stage** is the same as the preliminary needle operation for linear extraction described on page 258. Two, three, or four days having elapsed, *the second stage*, or suction part of the operation, may be performed, and the whole lens, now opaque and diffuent, will be readily drawn through the tubular curette of the instrument.

The second stage, or the suction part of the operation, is carried out by a specially devised syringe fitted with a tubular curette, and is performed as follows:—The pupil having been previously fully dilated with atropine, an opening is made in the cornea with a broad needle immediately within the pupillary margin of the dilated pupil, sufficient in size to allow of the *easy entrance* of the tubular curette. A delicate manipulation of the instrument is required to move it from point to point, so as to place the open mouth of the curette in the most favourable positions for sucking in the lens matter without in any way injuring the iris. The suction power must be carefully regulated by the operator, who is able to arrest it instantly if necessary.

In the suction instrument made by Messrs. Weiss the suction is obtained through a delicate metal syringe placed at one extremity of a glass tube, which is furnished at the other end with a tubular curette, the aperture of which is countersunk. The syringe is so contrived that with one hand the piston can be worked and the movements of the curette within the eye guided, whilst the other hand is left free to fix the globe with a pair of forceps.

In the instrument devised by Mr. Teale, the suction power is applied by the mouth of the operator. It consists of a glass tube, to one end of which is fastened a tubular curette, whilst to the other extremity is attached a piece of india-rubber tubing with a glass mouth-piece. This operation is now rarely performed, and it presents no advantages over the "linear" method previously described.

C. SENILE CATARACT.

Senile cataracts rarely occur before fifty years of age. Two main varieties can be distinguished which may sometimes occur together in the same eye :

1. **Nuclear Cataracts**, in which the opacity commences centrally as an ill-defined haze situated in the perinuclear zone.

2. **Striated Cortical Cataracts**, in which the opacity commences peripherally, and first shows itself as opaque striæ or lines in the cortical substance, which radiate from the circumference towards the centre of the lens. Besides these regular striæ, others of irregular distribution, or sometimes sector-shaped opacities, may be present. This is by far the more frequent variety. Both varieties merge into one another as the whole lens becomes gradually involved.

The cataract is said to be **immature** when the lens is only partially opaque. It is called **mature** when the opacity has involved the whole lens, and this is the most favourable time for its removal, for the lens can then be extracted clean from its capsule. After cataracts have become mature they are apt to slowly undergo degenerative processes consisting, in some cases, of shrinkage, and in others of deliquescence of the lens fibres, and they are then said to become **hypermature**.

Senile cataracts vary greatly in consistence, but are always distinguished by the presence of a distinct firm nucleus. In some, the nucleus occupies the greater portion of the lens, which is then hard and amber-coloured, whilst in younger patients there is often a considerable amount of soft cortical matter. There is also a small class of hypermature cataracts in which the cortex has become wholly or partially converted into a fluid, sometimes containing cholesterine crystals, and of a milky, or more rarely of a dark sepia colour; and at the bottom of which lies the nucleus (*Morgagnian Cataract*).

The cataractous lens is usually of a pearly-grey colour, but variations are frequent. A very white, milky-looking lens frequently betokens hypermaturity. On the other hand, some cataracts, especially those with a large nucleus, are exceedingly dark,—of a reddish-brown colour,—and are then known as black cataracts. In some such cases the dark colour may be due to staining of the lens by hæmatine from some prior extravasation of blood into the anterior chamber.

Ætiology.—Of this we know little. Generally speaking, it must be regarded rather as a physiological than a pathological process. Certain conditions do, in some cases, seem to predispose: long-continued illness, severe mental worry, or years of hard living; or, in other words, conditions that predispose to premature decay. It has been suggested that conditions of ametropia, especially astigmatism when uncorrected, predispose, but there is no direct proof of this assertion.

Symptoms.—Both eyes are usually affected, but not simultaneously. According to our experience, in a majority of cases the cataract commences in the left eye, and in its subsequent progress keeps in advance of the cataract in the right. The earliest symptoms are vague, and may assume several forms. Sometimes a general mistiness is the complaint; in others that the sight is better at one time of the day than at another, depending on the situation of the cataract, which, if



FIG. 126.—Senile cataract.

A. Front view. B. Sectional view.

nuclear, causes more confusion when the light is bright and the pupil contracted, whereas if only the periphery of the lens is involved, the sight is best when the contracted pupil shuts out the cataractous segments. In many cases the first complaint is with regard to glasses which do not answer as before. The surgeon finds that the convex reading glasses have to be weakened, owing to an increase in the refractive index of the lens, which makes a formerly emmetropic patient slightly myopic, and so on. Other cases, again, complain of *polyopia*, which is due to the irregular refraction of the lens, so that two or three indistinct images are formed upon the retina instead of a single clear one. As the cataract becomes more pronounced these symptoms merge into a generally-expressed inability to see things near or far, either with or without glasses.

The **diagnosis** is made by oblique illumination, or by the ophthalmoscope. A very cataractous lens can be recognised by mere inspection; but the inexperienced are apt to mistake the sclerosed lens of old age for cataract. A merely sclerosed lens diminishes the luminosity, and imparts a dull yellowish colour to the pupil; but when examined by transmitted light such a lens is seen to be quite transparent. By oblique illumination lenticular opacities appear as faint grey lines or spots, which, when viewed by transmitted light, stand out black upon the red background. The absence of undulatory or floating movements, on altering the position of the eye, will serve to distinguish them in cases of doubt from opacities in the vitreous. A diagnosis of early cataract should never be made without examination by one of these methods, and very often it is desirable to dilate the pupil, taking care to assure ourselves that the tension of the eye is normal before doing so.

When a lens is becoming cataractous, the anterior chamber becomes slightly shallower, owing to swelling of the lens fibres, and this increase in bulk may even give rise to glaucomatous symptoms by causing undue pressure upon the angle of the anterior chamber. When the cataract is complete, the lens slowly shrinks, and ultimately becomes smaller than its original size, so that in hypermature cataracts the anterior chamber is deepened, and the iris sometimes slightly tremulous from lack of support.

The **progress** of senile cataract is very variable, the process being completed in a few months in some cases, whilst in others it may take many years before the lens becomes entirely opaque. Again, it may progress slowly in the early stages, but develop quickly at the last. It therefore devolves upon the surgeon to be cautious in giving an opinion upon this point, especially after only one examination.

To **estimate advance towards maturity**, oblique examination and the ophthalmoscope should be employed. A cataract is mature when the opacity reaches everywhere to the anterior capsule without allowing any clear space to be seen between the plane of the pupil and that of the opacity. The reason of this is that the most superficial fibres of the cortex are invariably the last portion of the lens to become opaque; so that if the opacity reaches right up to the surface, the cataract must be mature. To elucidate the latter point is often quite

easy by mere inspection with oblique illumination, but if any doubt is felt it can be cleared up by noting whether any shadow of the iris is cast upon the lens when a light is thrown obliquely into the eye. If no shadow appears, it is certain that the lens is totally opaque. We can estimate lesser degrees of opacities very well with the ophthalmoscope by noting to what extent the red fundus reflex has been abolished. When the cataract is mature, no fundus reflex can be seen at any point with the pupil dilated, and vision is reduced to hand-movements and the perception of light.

It is of the greatest importance to form an opinion as to the general soundness of the eye before undertaking an operation for the removal of a cataract. In many cases the examination of the other eye will help materially, but this may be impossible from the other lens being also opaque. Consequently we require a special test for the purpose, and this we have in the patient's capability to perceive and project light when thrown on the eye from various directions (the method of performing this examination is described on page 29). If the fundus of the eye is healthy, light perception and light projection will be acute in all portions of the field, however opaque the lens may be.

Treatment of Senile Cataract.—In the early stages treatment is purely palliative. Where both eyes are affected the patient will often obtain considerable benefit by using a weak mydriatic every morning or two or three times a week (atrop. sulph. gr. $\frac{1}{4}$ ad $\frac{3}{j}$ or homatr. hydrobrom. gr. $\frac{1}{4}$ ad $\frac{3}{j}$), according to the effect produced. Care must be exercised in ordering a mydriatic in old people, for fear of inducing a glaucomatous attack. It should not be ordered in any case where the tension is full, and in all cases the patient should be warned to discontinue the drops should they cause any pain. Lightly tinted neutral protectors for out-door use will act in the same way as a mydriatic, and are often preferable. When the opacity is chiefly peripheral, stenopœic glasses are sometimes of service. A low concave glass will frequently improve the sight for distant objects, and may be ordered for occasional use. Convex reading glasses must generally be weakened, and frequent changes may be needed as the sight alters. Often the patient reads best without any glasses.

When the cataract is mature, the most favourable time for its extraction has arrived. The operation should be delayed in most cases until maturity, because otherwise the lens will not come away clean from its capsule, but will leave behind some sticky cortical matter, and this will not only delay the result of the operation, but is very apt to set up iritis. So, too, hypermature shrunken cataracts are removed with greater difficulty, and under less favourable conditions than mature cataracts, on account of consecutive atrophic changes in the suspensory ligament, which allow the lens to be easily dislocated, and increase the danger of loss of vitreous. Operation can generally be conveniently delayed when only one eye is affected; but it often happens that the cataract is slowly advancing in both eyes, and the sight has become so far dimmed as to prevent the patient from following the business on which his daily bread depends. In such a case the patient cannot afford to wait, and one of three courses may be pursued.

1. The lens may be removed from one eye by an extraction operation with iridectomy (*see* page 269). If some soft cortical matter remains behind, the pupil must be kept dilated with atropine after the section has united.

2. Before attempting any operation the surgeon may tear through the central portion of the lens capsule with a fine needle, so as to freely admit the aqueous and render opaque the transparent portions of the lens. The patient should then be placed for a few days in a darkened room, and the pupil kept under the influence of atropine, so as to ward off any of the inflammatory effects which wounding a sclerosed lens will sometimes produce. When all irritation has subsided, the opaque lens may be extracted by the operation the surgeon may select.

3. A *massage operation* for artificially maturing the cataract may be performed. The pupil having been well dilated with atropine, the cornea is punctured and the aqueous allowed to escape, and the anterior surface of the lens brought to rest against the back of the cornea. The lens is then gently massaged through the cornea with a shell spoon with the intent to bruise the lens fibres. The eye is then tied up for a few days, and kept under the influence of atropine until all irritation has subsided. The operation, which is a modification of one introduced by Förster some years ago, is not altogether free from risk; the danger being the bruising of the iris or the rupture of the suspensory ligament and dislocation of the lens by the exercise of too much force. It generally causes the maturation of the cataract in a few weeks, but occasionally it fails in producing the desired effect.

The question of operating when there is a mature cataract in one eye, but the sight in the other is either unimpaired or the eye retains useful vision, frequently arises. A good general rule may be laid down:—“*Do not operate unless the sight in the other eye is so rapidly failing that useful sight is already abolished or probably will be by the time treatment in the first eye is completed;*” because—

1. If the unoperated eye retains good vision, the patient will always use it in preference to the operated eye.

2. Binocular vision can never be restored, on account of the difference in the refraction of the two eyes.

3. The extraction of the cataract is apt to lead to attempts at binocular vision, which result in confusing and blurring the sight of the unoperated eye, and thus the extraction may actually inconvenience and distress the patient.

Exceptions can be made to this rule when the lens seems to be shrinking, and the time is passing for favourable extraction; when it is desired to remove the opaque lens for cosmetic reasons; and in the case of navvies, seamen, etc., in whom the absolute loss of sight on the affected side constitutes a source of danger.

If we have reason to fear that we are dealing with an eye with fluid vitreous, which we are led to suspect from disease in the fundus of the other eye, the presence of vitreous opacities, a history of long-standing iritis or irido-cyclitis with the presence of numerous iritic adhesions, or, again, from the existence of very high myopia, it is best to perform the operation of extraction in two stages. At the first

sitting a "**preliminary iridectomy**" is made, and then some weeks later the extraction is completed by the removal of the lens. The lens is thus delivered with the least possible disturbance of the parts, and the danger of loss of vitreous is minimised.

Lastly, when both eyes are affected with mature cataracts, the two operations should *never* be performed at the same time. The risk is too great. Some accidental cause, which on a future occasion might be averted, may influence the patient unfavourably, and both eyes may be lost. No operation should be done on the second eye until the result of the first has been decided.

For capsular opacities following the removal of the lens and their treatment *see* page 279.

For the description of the operation to remove a senile cataract *see* page 269.

For the prescribing of glasses after removal of the lens *see* "Aphakia," page 287.

D. TRAUMATIC CATARACT.

Traumatic cataract, or cataract the result of an injury to the eye, may occur either with or without a rupture of the external coats of the eye.

I. Traumatic Cataract with Rupture of the External Coats of the Eye.—One of the most frequent complications of a wound of the cornea is an injury to the lens. Wounds of the lens terminate almost invariably in cataract. Within twenty-four hours the point of injury is indicated by an opaque patch, and this opacity gradually increases until the whole lens becomes opaque. The rapidity of the formation of the cataract will depend partly on the extent of the injury inflicted on the lens and its capsule, and partly, also, on the age of the patient. If the rent in the capsule is large, and the lenticular matter has also been broken into, the aqueous humour will be rapidly brought into contact with the lens substance, and its transparency will be quickly destroyed. In the young, the lens is soft, and becomes more rapidly cataractous from an injury than in the aged, where it is more dense, and has a firm nucleus. The immediate effect of a wound of the lens is the admission of the aqueous within its capsule. This is imbibed by the lens tissue, each part of which becomes opaque, and rapidly swells as it is brought under the influence of the aqueous; so that the swelling of the lens increases with the opacity until the whole is opaque. The lens thus swelling, frequently presses on the posterior surface of the iris, and excites great irritation; hence it is of the utmost importance that the pupil should be kept fully dilated with atropine, in order to afford space for the swelling lens, and as far as possible to prevent it from pressing on the iris.

The irritation which is thus excited by a cataractous lens is greater and more apt to occur in the adult and aged person than it is in the child. The most serious symptom which the pressure of a swollen lens on the back of the iris is apt to produce is a glaucomatous hardness of the globe—a condition known as **traumatic glaucoma**. It is ushered in

with increased pain and irritation; the anterior chamber is diminished in size from the lens having pushed the iris forwards towards the cornea; the eye has a pinkish tinge from a general fulness of the sclerotic vessels, especially of those which form the ciliary zone; and the tension of the globe is increased. This condition is fraught with danger, and always demands immediate treatment.

Traumatic cataract with rupture of the external coats of the eye is very commonly associated with a prolapse or laceration of the iris, or with both; indeed, it is more usual for it to be accompanied by some lesion of the iris than for the injury to be confined to the lens. In a few cases the cataract may only involve a portion of the lens, leaving the rest clear and transparent. This can only happen when the primary wound is very small and from some cause, such as the adhesion of a tag of iris, has been speedily closed. We have recently seen a case where this had happened, and on superficial inspection a year after the accident the case much resembled one of lamellar cataract. In another case, where the injury was effected by a splinter, the cataract was confined to an area not bigger than a pin-point; the lens having been barely pricked by the splinter.

2. Traumatic Cataract without Rupture of the External Coats of the Eye, or Concussion Cataract.—Sudden violence applied to the eye, or to the bony parts which surround it, may, without any rupture of the external coats of the eye, cause a rent in the capsule of the lens sufficient to allow the aqueous to permeate its structure and to render it cataractous. Von Graefe noticed that in such cases the rent is generally at the periphery of the lens, or within the area of the thin posterior capsule, but never in the middle of the anterior capsule.

Again, a blow on the eye may, without any apparent injury of the lens capsule, so disarrange the internal structure of the lens that its nutrition will become impaired, and as a result its transparency will be destroyed. This accident is more rare than the preceding, in which the lens capsule is torn. The form of cataract which is usually produced is a diffused opacity; a portion of the lens first becomes nebulous, and this nebulosity increases until the whole lens is opaque.

Treatment of Traumatic Cataract.—**I.** If the cataract is *uncomplicated with injury to the iris*, and has been caused by some fine, sharp-pointed instrument penetrating the cornea, there is good reason to hope for a favourable result. A solution of atropine (grs. ij ad aquæ ʒj) should be dropped twice or three times a day into the eye to dilate the pupil fully, and thus to keep the iris out of the way of the swelling lens. A compress and bandage should be fastened over the closed lids, or, if it is more comfortable, a fold of linen wet with some cooling lotion may be laid over the eye. If there is pain in the eye or around the orbit, two leeches should be at once applied to the temple. The patient should be kept in a darkened room. If, after all the irritation occasioned by the injury has subsided, a gradual absorption of the lens matter is found to be going on, it is wise not to meddle with the cataract, but to keep a careful watch over the eye, and be prepared to treat symptoms as they arise, being guided by them in the future management of the case.

2. If the wound in the lens is *complicated with injury to, or prolapse of, the iris*, attention must first be directed to the iris, and the prolapsed portions carefully removed (*see also* "Prolapse," page 215); but it is best, if no glaucomatous symptoms arise, to leave any treatment of the lens until the eye has recovered from the primary shock of the injury.

Whenever a traumatic cataract excites great irritation or induces symptoms of traumatic glaucoma, the lens should be at once removed. The operation to be selected will depend on the density of the lens, the general condition of the eye, and the age of the patient. As a rule, when the lens is *soft*, a linear extraction should be performed, and an iridectomy may be combined with this operation if circumstances render it advisable. If, however, the patient is advanced in years, and the lens consequently more or less hard, the best operation will be the extraction operation with iridectomy (*see* page 269); but the operation should not be undertaken without due consideration, as there is considerable risk of loss of vitreous, owing to rupture of the hyaloid membrane at the time of injury, and this risk becomes a certainty when we have evidence that the lens is partially or wholly dislocated.

E. DIABETIC CATARACT.

The only peculiarity in this variety of cataract is its origin. The opaque lens presents no characteristic to distinguish it from cataract arising from other diseases or from senile decay. As diabetes frequently attacks young people, this disease may be considered as one of the causes of cataract in early life. In diabetic cataract the opacity is probably dependent on impaired nutrition.

Treatment.—The same as for senile cataract, unless the patient happens to be very young, when the operation of "linear extraction" may be employed. The presence of diabetes has been urged as a reason for not operating; but, though there is some slight risk, still, if the patient is apparently in fair health and not much emaciated, an operation is certainly not contra-indicated. We have on several occasions operated ourselves for diabetic cataract, and with good results, although the recovery is often slow and sometimes retarded by iritis. There is, however, one danger which must not be disregarded. The operation may excite an exacerbation of the diabetes, and the patient may drift into a diabetic coma which terminates in death. This misfortune has occurred once in our own practice, and we have personally known of another similar case. In our own case the diabetes had not only been long stationary, but a minimum amount of sugar was being excreted at the time of the operation; yet the fatal exacerbation appeared within twenty-four hours of the extraction.

F. SECONDARY CATARACT.

A cataract is called "secondary" when the opacity of the lens is dependent on, and secondary to, disease of the vitreous, choroid, or retina. In these cases the lens not only grows opaque, but frequently undergoes a further degeneration, and earthy salts, the carbonate and

phosphate of lime, are deposited both in it and in its capsule. The appearance of such a lens is very characteristic; it is usually somewhat shrunken and flattened, with a peculiar opaque chalky look, and either strikingly white or tinged slightly with yellow. It is often associated with other degenerative changes within the eye, and occurs conjointly with bony formations in the choroid and secondary detachments of the retina.

A special form of partial secondary cataract is known as **Posterior Polar Cataract**, and consists in a deep-seated opacity situated at the posterior pole of the lens. It occurs from the same causes as other forms of secondary cataract, and may remain stationary or ultimately progress until the whole lens becomes opaque.

Treatment.—Secondary cataracts, as a rule, are best left alone. In the majority of cases, the eye, when the cataract is complete, is blind, and the extraction of the lens would give no improvement of sight. Even in the most favourable instances, where there is some perception of light and a moderately active pupil, the fundus of the eye is usually so unsound that it is always doubtful whether the slight chance of benefit is sufficient to justify the risk of an operation. Certainly, when the patient has one good eye, no operation for the extraction of an opaque and chalky lens in the other should be performed.

Posterior Polar Cataract is not amenable to treatment. If it progresses and the cataract becomes complete, the prognosis of operation is unfavourable.

For congenital opacities at the posterior pole of the lens *see* page 254.

G. ANTERIOR POLAR OR PYRAMIDAL CATARACT.

This consists, as its name implies, of an opacity in the anterior pole of the lens immediately beneath the anterior capsule. It is a partial stationary cataract, and appears as a whitish patch in the centre of the pupil, whilst immediately opposed to it may in most cases be seen a corneal nebula. It is most frequently caused by a perforating ulcer of the cornea from “*ophthalmia neonatorum*” and the contact of the lens with the inflamed cornea. It may also very rarely occur in the same manner from a perforating ulcer in later life; but it is very much more likely to occur in infancy on account of the natural close approximation of the lens to the back of the cornea at that age. Very rarely no corneal nebula can be seen, and Treacher Collins* has also pointed out that the opacity may be congenital, occurring in foetal life, when the lens lies for a time in actual contact with the cornea. Collins* agrees with the

FIG. 127. — Anterior polar cataract.
A. Front view. B. Sectional view.



late Mr. Hulke in thinking that the cataract arises from the mere contact of the two structures, the lens and the cornea, the pressure upon the lens at the point of contact interfering with the nutritional

* ‘Researches into the Anatomy and Pathology of the Eye,’ p. 23.

osmosis and leading to a proliferation of cells beneath the anterior capsule at this point.

OPERATION FOR EXTRACTION OF SENILE CATARACT.

Instruments Required.—(1) Clarke's speculum (Fig. 130); (2) fixation forceps, one or two pairs (Fig. 132); (3) Graefe's cataract knife (Fig. 129) (for author's special measurements *vide* diagram); (4) iris forceps (Fig. 112); (5) iridectomy scissors (curved preferable) or De Wecker's forceps scissors (Figs. 111 and 117); (6) cystotome and curette (Figs. 131, 125); (7) vectis (Fig. 135); or (8) lens spoon (Fig. 136).

The operation to be described is the one that is undoubtedly attended with the most uniformly successful results. It is generally known as the "**three-millimètre flap operation**," and is the one now almost universally adopted. The main feature of the operation is that the incision lies in the corneo-scleral junction.

In the earliest days of cataract extraction the incision was entirely confined to the corneal tissue proper, and no iridectomy was employed (**Flap operation**) (Fig. 128, A). In order that the incision should be sufficiently large to allow of an easy escape of the lens, it was necessary to involve at least one half of the corneal circumference; the result being that the corneal flap had a tendency to fall forwards and gape. This encouraged prolapse of iris, and not infrequently caused delay in the union of the lips of the wound, with the dangers consequent thereon. Recognising these defects, von Graefe brought forward an operation in which the puncture and counter-puncture lay in the scleral tissue just beyond the corneo-scleral junction, thus producing an incision much shallower and forming the arc of a much larger circle (**modified linear extraction**) (Fig. 128, B). The operation was carried out with a large iridectomy, and a conjunctival flap was made. By this operation prolapse of the iris was avoided, the wound did not gape, and rapid healing was assured. It had, however, serious objections.

In the first place the operation was followed several times by sympathetic ophthalmitis, owing to the invasion of the ciliary region of the sclera; and, secondly, there was also a certain risk of loss of vitreous from the peripheral nature of the wound.

By adopting a mean between Graefe's and the old flap operation, that is, by having the incision just at the sclero-corneal junction with a short conjunctival flap, the advantages of Graefe's operation are attained without its drawbacks. The section forms the arc of a circle sufficiently large to admit of the ready presentation of all but the most bulky lenses. The incision is usually described as having its base

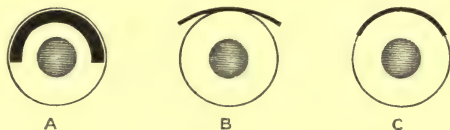


FIG. 128.—Diagram illustrating the various sections of the cornea used in the extraction of senile cataract.

A. The old flap operation. B. von Graefe's modified linear extraction. C. The 3 mm. flap operation now in universal use.

3 mm. below the summit of the cornea, that is, on the level of the summit of the pupil when slightly dilated by cocaine; or it can be more accurately measured by the width of the Graefe knife (see Fig. 129). If the lens is judged by the operator to be very large, an incision with a slightly broader base is required, a matter which must lie in the experience of the surgeon. The iris has much less tendency to prolapse than in either the old flap or von Graefe's modified linear operation; the wound lies well and heals readily; whilst there is very little risk of sympathetic ophthalmitis, much less bleeding, and less danger of loss of vitreous than in von Graefe's operation.



FIG. 129.—Von Graefe's narrow cataract knife. The author always employs the following measurements:—Length of blade from the pitch, 27 mm.; width, 2 mm. This is rather shorter than that illustrated, but is of the same width.

The section is almost universally made by von Graefe's knife (Fig. 129).

The operation is performed either with or without an iridectomy. There are many advocates of either procedure, but personally we are strongly in favour of, and always perform, an iridectomy. The chief object in iridectomy is to prevent prolapse of the iris or its incarceration in the wound. These are serious complications (see page 276 *et seq.*), and under the most favourable circumstances involve the reopening of the wound, and fresh risk to the eye; whilst in not a few cases, when the prolapse has been left or has for some time escaped observation, sympathetic ophthalmitis has been set up in the other eye. Iridectomy acts in preventing prolapse probably by causing a temporary paralysis of the muscle, and also perhaps, as Swanzy asserts,* by providing a gateway or sluice for the aqueous humour to escape in the early hours of healing without carrying the iris with it. A small iridectomy effects this purpose as well as a large one; and causes but very slight disfigurement, on account of its being concealed by the upper lid. Further, the paralysis it produces is purely temporary, and

the mobility of the remainder of the iris is soon fully restored. Another advantage of an iridectomy lies in the delivery of the lens with less bruising of the iris, and therefore with less chance of subsequent iritis. By not performing an iridectomy a certain cosmetic advantage is obtained, and there is certainly less astigmatism to correct when ordering glasses; but in our opinion the risks far outweigh the advantages. Even the most experienced operators have to contend with a certain percentage of cases of prolapsed iris when no iridectomy has been performed, and certainly, when the operation is performed by inexperienced surgeons, a small iridectomy should be a constant rule.

Description of the Operation.—A fresh, sterilised 2 per cent. solution of cocaine should be dropped into the eye once every five minutes for fifteen to twenty minutes before the operation. The patient should lie on

* 'Handbook of Diseases of the Eye,' 6th edit., p. 383.

his back with the head raised as desired. The chin is to be well sunk upon the chest, and the patient directed to keep the mouth slightly open.

The surgeon stands behind, and makes the incision with his right hand for the right eye, and with his left hand for the left eye. If he cannot use his left hand, he must stand in front for a left-sided cataract. The speculum is now introduced, first under the upper lid, telling the patient to look down, and then under the lower whilst the patient looks up. The patient is now directed to fix his gaze at some object so situated as to bring the summit of the cornea well into the surgeon's view.

The eye should now be fixed by seizing a small fold of the conjunctiva with the fixation forceps just below the margin of the cornea, either in the mid-line, or rather to the inner side if preferred. Some surgeons prefer that the forceps should be controlled by an assistant.

The knife, held between the thumb and first and second fingers, should now be made to enter the extreme edge of the cornea at the site previously given (page 270), with its point directed towards the centre of the pupil. As soon as the point is seen well within the anterior chamber, its direction is changed by depressing the handle, and the blade passed horizontally across the chamber to a point corresponding

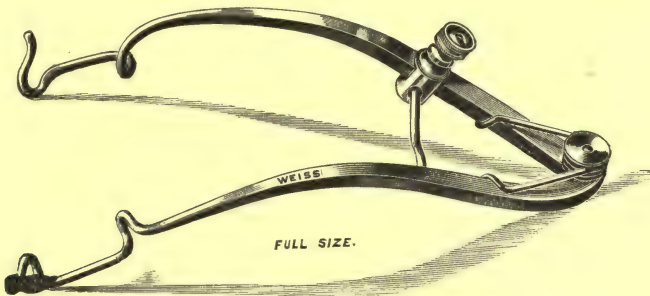


FIG. 130.—Clarke's spring speculum.

to and opposite to that at which it entered. After making the counter-puncture, the section is completed by cutting out with slow sawing movements along the curve of the corneo-scleral junction, taking care to keep the knife always firmly applied against the cornea to control the escape of aqueous, which might drive the iris over the edge of the knife. When the section is nearly completed the knife is turned forwards to cut a short conjunctival flap. The movements of the knife must be carefully regulated and entirely governed by the *wrist*. The surgeon's arm should be immovable, with the flexed elbow pressed against the side, and the forearm and hand rather supinated. Care should also be taken not to prick the patient's nose with the point of the knife, an accident that may easily happen, and which may make the patient wince.

The *second step* is the iridectomy, the advantages of which have been already considered. The iris forceps (Fig. 112) should be introduced closed into the chamber, and, when well within the eye, opened and a piece of iris seized, drawn well out of the eye, and excised. This should be done either by one snip of the scissors (Figs. 111 and 117),

or by cutting first one side and then the other, taking care in this case to draw the iris towards the centre of the wound before each cut, so as to prevent any entanglement of the cut edges of the iris in the angles of the wound.

The *third step* is the opening of the lens capsule. This may be effected either with the point of the cataract knife, or with the cystotome (Fig. 131), or with the capsule forceps (Fig. 133). When we believe we have to deal with fluid vitreous it is advisable to make a *peripheral* section of the capsule. Either the knife or cystotome is introduced into the chamber lying flat; and then, having turned the cutting edge towards the capsule, the latter is cut horizontally along its upper periphery by one incision along its whole length. By this means the lens can be expelled with the least possible disturbance of the parts, and any sticky cortical matter left behind lies enclosed in the bag of capsule,

and is less likely to act as an irritant. The disadvantage of this method in normal cases is the necessity for a subsequent needling operation upon the capsule.

If we are dealing with a sound eye, the laceration of the capsule should be more free, and is best effected by the cystotome, which is introduced on the flat as before, and then made to lacerate the capsule by a T-shaped or crucial incision. Capsule forceps are dangerous except in expert hands. They are introduced closed into the wound, and the face of the capsule is then grasped and torn gently away. The risk lies in making undue pressure backwards on the lens, or dislocating it in tearing the capsule, either of which may involve loss of vitreous. This method should certainly not be used when dealing with an unsound eye.



FIG. 131.—Cystotome for lacerating the lens capsule.

The *fourth step* consists in the expulsion of the lens. The assistant having gently raised the speculum, so as to take all pressure from the eye, the surgeon slightly presses with the curette against the posterior or sclerotic edge of the wound, whilst with a second curette or with the tortoiseshell spoon (Fig. 134) in the other hand he makes gentle sliding upward pressure upon the lower part of the cornea. By this means the freed lens is urged into the wound, and is at the same time prevented from becoming jammed behind the posterior lip of the incision. As soon as the lens presents outside the wound the corneal pressure must be carefully regulated, and the lens followed up by the spoon, to prevent any undue force in the expulsion of the lens, which might be followed by a gush of vitreous from the sudden relief of tension. It generally happens that a little soft matter is left behind after the extraction of the lens. Attempts to expel this by gentle massage of the lower part of the cornea through the lid with the spoon should be tried after having first removed the speculum, and this device is aided by closing the eye for a minute or two, until some aqueous has been re-secreted, when the flow of the aqueous will help to draw the particles into

the wound, whence they can be removed by a dossil of absorbent wool.

Finally, inspection should be made, to see that the cut edges of the iris are not entangled in the wound, and also that no shreds of capsule are presenting. If the wound is not clear in these respects, the curette should be gently passed within the lips of the wound, and the iris and capsule gently smoothed back into the chamber.

The removal of the speculum should be conducted with great care, so as to avoid all pressure upon the globe. The stop having been loosened, the ends are to be approximated with the finger and thumb, and the arm beneath the upper lid first released. The lower lid is then drawn downwards with the finger, and the lower arm of the speculum set free. We have seen vitreous extruded by the careless removal of the speculum after a well-performed operation.

Irrigation of the eye after extraction is not needed, and should be avoided. Before finally closing the eye, any adherent clots of blood may be removed by the iris forceps. *Both* eyes are then closed and covered by a light antiseptic dressing surmounted by a bandage, the most convenient form of which is the Moorfield's bandage (F. 1). Many different forms of dressing are favoured by different surgeons, but there is nothing more efficacious than a simple pad of Gamgee tissue with a little boric ointment smeared over it on the side next the eye.

Treatment of the Eye after Extraction.—The patient should be kept in bed for four or five days, both eyes being kept bandaged until the third day, when the sound eye may be released. It is an excellent plan to hobble the hand of the side upon which extraction has been performed by a bandage, forming a clove hitch over the hand, whilst the other end is fastened to the foot of the bed, and of such a length that the forearm cannot be flexed beyond a right angle. Many good operations have been spoilt by accidental blows or rubs delivered unconsciously by the patient when asleep, or betwixt sleeping and waking. If the patient is very old, it is safer to let him sit up on the sofa or propped up in bed after the second day, for fear of static pneumonia. The bandage should be changed every morning, as the flow of tears renders the pad wet and uncomfortable, and at each dressing a little of the Ung. Atrop. (F. 57) should be gently placed within the conjunctival sac, and continued until all ciliary redness has disappeared.

The eye should not be *examined* until the third day at earliest, unless there is some reason for it, such as the fear of prolapsed iris when no iridectomy has been performed. There is always a little pain after the

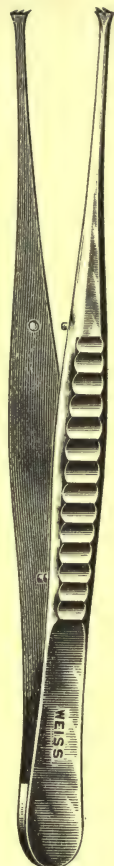


FIG. 132.—Conjunctival fixation forceps.

effect of cocaine has worn off, but this should have passed away in twenty-four hours, and if there is no further pain and the lids are not puffy, we need feel no disquietude as to the state of the eye. If the lids become gummed together, a piece of lint or wool wet with warm boracic lotion should be drawn a few times across their tarsal borders, and then gently pulling down the lower lid with one finger, they may be sufficiently parted to allow any pent-up tears to escape. If the patient should complain that the pad makes the eye hot, it may be removed, but a fold of lint over the eyes and the bandage should be continued.

After about eight or ten days the bandage may be given up, and dark glasses substituted. Once or more often during the day the lids should be bathed with warm boracic lotion, or, if there is any irritation, with the belladonna lotion (F. 41). When there is restlessness after the operation, an opiate, or, what is better, a subcutaneous injection of from one sixth to one fourth of a grain of morphia, should be given at night-time; and if the patient complains of severe pain in the eye, sufficient to prevent sleep, two or three leeches should be applied to the temple. If these fail to give relief, the bandage should be removed, and a fold of lint wet with cold or iced boracic lotion should be laid over the closed lids, and changed as often as it becomes hot or dry. A mild purgative must be ordered if necessary, so as to ensure the regular daily action of the bowels without straining. The patient should be allowed his regular diet, with the exception of the two days following the operation, when it is generally advisable to permit only beef-tea and farinaceous food, in order to avoid as far as possible all movements induced by mastication.

If all goes well, the patient may be allowed to go out of doors in about fourteen days, the eyes being protected by dark, neutral-tinted protectors. The patient should not be tried for glasses until six to eight weeks have elapsed since the operation.

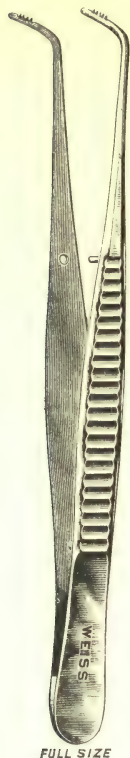


FIG. 133.—Couper's capsule forceps.

Accidents that may happen during the Operation:

1. **The Iris may be Pricked by the Knife.**—An attempt should be made to disengage the knife by slightly withdrawing it; but if this is impracticable it is best to continue the section and include any wounded portion of iris in a subsequent iridectomy.

2. **The Iris may Fall in Front of the Knife,** owing to the aqueous escaping too soon. The accident is caused by failing to keep up a continuous pressure on the cornea with the knife whilst completing the section. When it happens, the surgeon should press the cornea gently against the blade with one of his fingers whilst at the same time he continues the section with the edge of the knife turned slightly

forwards. By this manœuvre the iris will often be made to recede, and the section be completed without cutting the iris. Should it fail, however, the section should still be completed, though it will include a fold of the iris. Care must then be taken to see that such a detached portion of iris is not left in the eye, where it will act as a foreign body. We have known a case where the eye was subsequently lost from the irritation set up by a small piece of necrosed iris which was detached in the way just mentioned.

3. **Excessive Hæmorrhage from the Iris.**—This may be sufficient to entirely obscure all the parts from view. It is then best to wait for a minute or two until bleeding is arrested and some fresh aqueous re-secreted, and then the blood can be gently induced to run off with the aqueous, and any adherent clots be removed with the iris forceps or a dossil of absorbent wool.

4. **Escape of Vitreous.**—This may be due to a variety of causes. (1) Fluidity of the vitreous and weakness of the hyaloid from disease. (2) Pressure from an intra-ocular hæmorrhage. (3) Cases of traumatic cataract or dislocated lens where the hyaloid has been ruptured. (4) Straining and struggling of an unruly patient. (5) Undue roughness on the part of the surgeon. (6) A too peripheral section of the sclerotic.

The vitreous may escape either *before* or *after* delivery of the lens. The escape of vitreous *before* the delivery of the lens is a very serious mischance, and renders the completion of the operation very difficult. All pressure on the eye by the speculum should be at once relieved, and the lens with its capsule withdrawn from the eye, if possible, by means of a cataract spoon or a vectis. This is best accomplished by gently introducing the spoon, using scarcely any perceptible force, but urging it onwards by one or two slight lateral movements. The spoon should be directed first a little backwards, so as to insinuate its extremity behind the lens, and then, passing it downwards and slightly forwards, it should be allowed almost by its own weight to follow the posterior curvature of the lens. Having secured the lens within its grasp, the instrument is gradually withdrawn, slightly depressing the handle during this movement so as to draw the lens with it out of the eye.

When a gush of vitreous *follows* the escape of the lens the eye should be closed as quickly as possible and a bandage applied. If the vitreous is *not* fluid it is, however, important to clear the wound with scissors of any protruding tag, which, if left, is particularly liable to be a source of infection and the means of inducing a destructive inflammation of the globe.

The escape of vitreous, though a serious matter, is not fatal to the result of the operation unless a large quantity is lost. The aqueous partly takes the place of the lost vitreous, and very useful sight may be retained, even though the globe may appear semi-collapsed at the



FIG. 134.—Tortoise-shell spoon.

completion of the operation. The most serious complication that may follow the accident is detachment of the retina, in which case the sight is hopelessly lost, and, lastly, when a large quantity of vitreous has escaped the eye is liable to undergo slow degenerative changes which result in atrophy and shrinking of the globe.

5. **Deep Intra-ocular Hæmorrhage** may occur. This is the most fatal accident that can happen, the eye being always irrecoverably lost. It most frequently occurs in eyes which are glaucomatous, and the bleeding usually takes place between the choroid and sclerotic (*see also* p. 329).

6. **Difficulty or Failure to Deliver the Lens.**—(a) *The section may have been made too small.* This will very rarely happen if the lines of the section as previously described have been carefully followed. Attempts should not be made to force the lens through too small an opening. The wound may easily and safely be enlarged by scissors or knife.

(b) *The upper edge of the lens may get caught in the posterior lip of the wound.* The lens may be disengaged by pressing the point of the cystotome into the lens and pushing it gently downwards, care being taken at the same time to relax all pressure from below until the lens is freed.

(c) *The lens may be dislocated into the vitreous chamber, or couched.* This is an awkward accident, and most likely to happen in attempting to extract a lens that has been already partially dislocated, or when the vitreous is fluid and the zonule atrophied from long-standing disease. An attempt may be made to extract the lens with a spoon, but if one or two attempts fail, it is best to leave the eye alone. The disaster is sometimes followed by destructive inflammation of the eye; but more often the irritation caused by the dislocated lens is slight and gradually passes off, and the patient may obtain very fair vision. It must be remembered that couching the lens used to be the recognised method of dealing with a cataract, and is the method still adopted in the East.



FIG. 135.—Taylor's vectis, with platinum stem, which can be bent to any angle desired.

Accidents that may happen after Extraction.—

(1) *Prolapse of the iris*; (2) *iritis*; (3) *glaucoma*; (4) *striped keratitis*; (5) *suppuration of the cornea*; (6) *panophthalmitis and suppuration of the globe*; (7) *imperfect union of the corneal wound, and subsequent fistula*; (8) *cystoid cicatrix*.

I. **Prolapse of the Iris** may come on from the first to the fifth day after an extraction operation in which no iridectomy has been performed, and sometimes even later. In some cases it seems to be due to the pressure or irritation excited by some cortical lens matter left in the pupil at the time of the operation, and in others the probable cause is some spasmodic action on the part of the patient, such as coughing and sneezing, or some straining exertion of the body or head.

Treatment.—The prolapse should be at once removed as soon as discovered by gently reopening the wound, and then, having drawn the prolapsed iris well out, cutting it away by pressing the scissors well down to the wound, so as to ensure a free removal of the entangled portion.

2. *Iritis.*—*Chronic serous iritis* is the most usual form, and is a frequent cause of increased tension after an extraction operation. It commences as a rule from one to three weeks after the operation. It is always accompanied by photophobia and lachrymation, and frequently with the edges of the lids puffy, thickened, and excoriated. *For treatment see "Serous Iritis,"* page 207.

Acute Iritis is comparatively rare. It usually occurs on the second or third day after the operation, and unless soon arrested may lead to the destruction of the eye. It may be due to undue roughness on the part of the operator, or to bruising of the iris in delivery of the lens, or to the irritation set up by cortical matter remaining behind. It is especially apt to occur in gouty patients or those of plethoric habits. When it sets in during convalescence it is usually the result of an accidental blow or rub.

The *treatment* is the same as that advised for traumatic iritis (page 205).

There is a strong tendency in this form of traumatic iritis to spread to the neighbouring tissues, and thus to drift into panophthalmitis, ophthalmitis, or general inflammation of the eye.

Short of destroying the eye, both the acute and chronic forms of iritis are very apt to lead to complete blocking or occlusion of the pupil by inflammatory adhesions and exudation, which will necessitate further operation for its relief (see "Iridotomy," page 223).

3. *Secondary Glaucoma.*

—As already said, increase of tension is frequently due to increased exudation in serous iritis, and the organisation of such exudation may ultimately lead to a true glaucoma; but besides these cases there is another special form of glaucoma which occasionally sets in

after extraction of cataract, and which is due to the incarceration of the iris or lens capsule in the scar.* Glaucoma arising in this way may set in soon after the operation, or its onset may be delayed for some months.

* 'Researches into the Anatomy and Pathology of the Eye,' p. 108 (Treacher Collins).

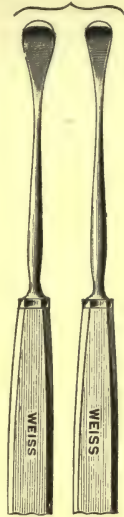


FIG. 136.—Crichtett's cataract spoons.

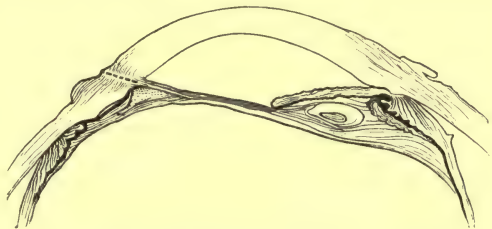


FIG. 137.—Secondary glaucoma after extraction of cataract owing to entanglement of the capsule in the wound and blockage of the filtration angle. The dotted line shows the position of the scar. (After Priestley Smith.)

Treatment.—Operative measures are needed : either a further iridectomy or a sclerotomy should be performed, or in a few cases, if the pupil be completely blocked by membrane, a needling operation to divide the membrane and open up a passage between the anterior and posterior chambers may be sufficient to reduce the tension.

4. **Striped Keratitis.**—This consists of a striated opacity of the cornea which in rare cases sets in a few days after an extraction. Its ætiology is doubtful. Hess,* who has investigated several cases very carefully, considers that it is due to folding or wrinkling of the posterior corneal layers. In some cases it seems to have followed the employment of too strong antiseptic lotions. No special treatment is required. The cloudiness generally passes gradually away, though it occasionally persists for months, or may rarely leave a permanent opacity.

5. **Suppuration of the Cornea** may be either partial or complete. It may commence in the line of the incision and involve more or less of the corneal flap, to which it may be limited, or it may be diffuse and include the whole cornea.

Symptoms.—Increasing pain in the eye and around the orbit, œdematous swelling and redness of the lids, chemosis of the conjunctiva, and a muco-purulent discharge.

If the suppuration is *partial* and *circumscribed*, the line of the incision will look opaque and yellow, and there will be some purulent infiltration extending into the corneal flap, whilst the lower part of the cornea, although perhaps slightly turbid, will still retain some of its transparency and polish. This condition of the eye, though very serious, is not hopeless if the suppuration can be confined to the margin of the wound. The dangers are—(1) that the suppuration will become diffuse; (2) that it will extend to the deeper structures and induce a suppurative inflammation of the globe; and (3) that although the corneal suppuration may be subdued, a secondary iritis or irido-cyclitis may follow, which will in the end produce softening and atrophy of the globe.

When the suppuration of the cornea is *diffuse* or *complete* the symptoms are the same but intensified. The eye must then be considered as irreparably lost.

It is worth noting that in old and feeble patients suppuration of the cornea will occasionally occur without the usual inflammatory symptoms of pain with redness and swelling of the lids being manifested; and therefore if the eye is kept sealed up for a week after operation, as is the practice of some surgeons, the first examination may reveal an already hopeless state of affairs.

Treatment.—As soon as suppuration has set in, warm fomentations of poppy heads or belladonna should be employed and reapplied every two or three hours. A solution of atropine (gr. iv ad ʒj) should be dropped twice or thrice daily into the eye, and between the application of fomentations the eye should be well soaked in a solution of quinine (F. 50), which is an excellent and painless germicide. Pain should be relieved by repeated doses of opium, which may be combined with

* 'Graefe's Arch.,' 38, 4, p. 1.

ammonia, quinine, or liq. cinchonæ. The patient should be liberally dieted, and a moderate allowance of stimulant ordered for him. The application of two or three leeches to the temple often gives great relief, and may be repeated. If the inflammatory process is very acute, or if in spite of the above measures suppuration slowly extends, the advancing edge of suppuration may be lightly touched along its whole length with the galvano-cautery; but in our opinion this method of treatment, though frequently of great service, needs to be employed with great discretion, and in old feeble patients is apt to do more harm than good.

6. Panophthalmitis and Suppuration of the Globe.—When this happens the eye is lost, and is best removed. The only other course to be pursued is to hasten the suppuration by warm and soothing applications, to give free vent to the pus by an incision through the cornea if necessary, to relieve pain by opiates, and to support the patient by tonics, stimulants, and a good diet.

7. Imperfect Union of the Corneal Wound and consequent Fistula.—From some cause, often difficult if not impossible to explain, the wound of the cornea after the extraction of cataract fails to unite completely, and a small fistula remains through which the aqueous slowly dribbles.

Treatment.—A compress bandage should be placed over the closed lids, and twice a day a few drops of a solution of atropine (gr. ij ad aquæ ʒj) be dropped into the eye. This treatment generally succeeds in closing the fistula, but if after a fair trial it produces no effect, the opening in the cornea may be touched with a fine camel's-hair brush charged with nitrate of silver, as recommended on page 160.

For the symptoms and further treatment of corneal fistula see "Fistula of the Cornea."

8. Cystoid Cicatrix.—This can only occur when the incision has been made in the sclerotic. It is due to the edges of the wound not coming into close contact, owing to the engagement of a piece of iris or lens capsule in the lips of the wound. The wound then heals up by the intervention of cicatricial tissue, which gradually yields before the intra-ocular pressure, and becomes thin and bulging.

Treatment.—If the cystoid cicatrix is small or gives no inconvenience, it is best to leave it alone. When large or troublesome it may be punctured with a broad needle. If the bulging of the cicatrix is on the increase and the tension of the eye is glaucomatous, an iridectomy should be performed.

CAPSULAR OPACITIES.

Capsular Opacities following the Loss of the Lens.—After the lens has been removed, either by absorption or extraction, some density of the capsule which has been left is very apt to occur, and greatly mars the excellence of vision which the patient would otherwise possess. The degree of opacity varies very much, and is dependent on different circumstances.

The simplest form of Opacity of the Capsule is that which often

occurs after an operation for the removal of the lens, especially after linear or suction extraction. Its formation is unaccompanied by any inflammatory action. Examined with the ophthalmoscope, a film of wrinkled capsule will be found occupying the pupillary space, not actually opaque, but with its transparency sufficiently dulled to interfere with the due passage of light to the fundus of the eye.

The second form of Opacity of the Capsule is where the membrane itself is semi-opaque, and its opacity considerably increased by bits of soft lenticular matter having become enclosed between parts of the anterior and posterior layers of the capsule. If the pupil be dilated with atropine, the opacity of the capsule will be seen to vary in density in different points of its area, according to the quantity of lens matter which has been enclosed between its layers. This form of opacity is not necessarily accompanied by any inflammatory action.

The third form of Opacity of the Capsule is always associated with iritis. Lymph is effused on to the surface of the capsule, and adhesions more or less extensive between it and the iris close the pupil. The capsule itself becomes opaque, and, blending with the lymph upon its surface, grows tough and almost fibrous in its structure, losing all its natural elasticity. This state of the capsule is very frequently combined with some soft opaque lens substance shut in between its layers; indeed, in many cases the iritis is due to the irritation which has been excited from some lenticular matter having been left behind at the time of the operation for the extraction of the lens.

The two latter forms of membranous opacity are liable after a lapse of time to undergo degeneration of structure. Thus the capsule may become brittle and friable, allowing a needle to pass through it like tinder, or in later years it may become the seat of earthy deposits.

Treatment of Capsular Opacities.—This consists in the case of the first two varieties in tearing through the opaque membrane with one or two fine needles (Figs. 138, 139), a procedure known as “**needling**” or “**discission** ;” and in the third variety of opacity in cutting through it with specially contrived scissors, an operation known as “**iridotomy**.”

Treatment of capsular opacities is not unattended with risk, and, indeed, in the opinion of many, which we endorse, almost as great a risk attaches to needling as to the extraction of an uncomplicated cataract. The risk seems to lie chiefly in the danger of setting up iritis from dragging on the iris during the operation, but partly also from the vitreous, which is wounded, being an excellent medium for the growth of pyogenic organisms.

Treatment is reserved for those cases in which the capsule is of sufficient density to prevent the patient from reading ordinary print with comfort. If able to do this, it is not advisable to submit the patient to the risk of further operation. It is therefore as well to have a standard upon which to determine what course to advise the patient, and it may be fairly said that if the patient can read J. 6 comfortably no operation should be recommended.

Needling or Discission Operation.—It may be taken as a rule which should never if possible be departed from, that no operation should be performed so long as the eye is red or irritable, nor within three

months of the extraction of the cataract. A single needle is usually sufficient to tear an opening through the semi-opaque or wrinkled capsule which is often found after an ordinary operation for cataract, but two needles should be in readiness in case a second is required.

Instruments.—(1) Speculum (Fig. 130); (2) fixation forceps (Fig. 132); (3) discission needles with either a long or short cutting edge as preferred (Figs. 138, 139).

Before commencing the operation the pupil should be fully dilated with atropine. The needle should penetrate the cornea obliquely about one or one and a half lines from its circumference, and passing across the pupil to the opposite side, it should puncture the capsule close to the iris, and then by slightly raising the hand, the needle is made to dip a little into the vitreous, and to cut its way through the capsule. In some eyes one or two dips of the needle will suffice to make a clear opening in the capsule, whilst in other cases they have to be repeated many times.

If the capsule is thick and tough, it is best to use two needles, passing the second through the opposite side of the cornea. The first needle can then be used to fix the capsule whilst the second cuts the rent. In this way the force employed is exerted upon the first needle instead of the capsule, and undue dragging upon the ciliary body, which will probably set up severe irritation, is avoided.

Occasionally it happens that after the needle has made an opening through the capsule an adherent film remains stretching across the pupil, which a single needle fails to divide. A second needle should then be used, after the manner first recommended by Sir W. Bowman. It should be introduced by the other hand through the cornea at a point nearly opposite to the first; and passing its point *behind* the band, whilst that of the first needle remains *in front* of it, so that their points cross, the one needle is made to revolve a few turns over the other, until the band of capsule is torn; or if this does not readily follow, the two needles may be then slightly but slowly separated, a proceeding which will seldom fail in breaking it through.

In cases where there is some lens matter enclosed between the anterior and posterior layers of the capsule, a needle operation such as has been already described will generally be sufficient. The breaking up of the capsule will expose the particles of lens matter to the action of the aqueous, and they will usually be quickly absorbed.



FULL SIZE

FIG. 138.—Bowman's stop-needle with a long cutting edge.



FULL SIZE

FIG. 139.—Bowman's stop-needle with a short cutting edge.

Needling the capsule from behind by passing the needle through the sclerotic behind the ciliary region (**Scleronyxis**) is a method practised by some Continental surgeons, who claim for it that greater force can be exerted to lacerate a tough capsule. The operation is rarely, if ever, performed, in this country. There are certain obvious risks, and the advantages seem hypothetical. Certainly the exertion of much force in needling is greatly to be deprecated, and if the capsule is tough or yields before the needle, a second needle should always be used as already detailed.

Iridotomy.—No operation should be performed if the eye is red or inflamed. It is the best method of treating a pupil closed by false membrane, or those cases in which degenerative processes and a deposit of earthy salts have occurred. The latter may often be diagnosed by the dense yellowish-white appearance of the capsule.

The details of this operation have already been described on page 224.

The operation will fail in not a few cases: either the membrane is so tough and inelastic that no gaping follows the cut, or subsequent inflammation closes up the opening again. Vitreous, too, is frequently lost, and the surgeon should be cautious when asked as to the chances of success.

After all operations for capsular opacities the eyes should be kept fully dilated with atropine until all irritation has subsided, and a protective pad should be worn for a few days.

DISLOCATIONS OF THE LENS.

Dislocations of the lens may be **complete** or **partial**.

They may be divided into three varieties. (a) **Congenital** dislocations; (b) **Spontaneous** dislocations, and (c) **Traumatic** dislocations.

a. **CONGENITAL DISLOCATIONS** are always partial, and are described on page 252.

b. **SPONTANEOUS DISLOCATIONS** may occur as the result of severe and long-continued disease of the uveal tract. They are brought about by atrophy of the zonule and loss of support from a shrinking or fluid vitreous, so that this variety of dislocation is always backwards. The lens is always cataractous, and usually very shrunken. No special treatment is required, as the eye is usually lost, and if some sight remain, it may possibly be improved by the accident.

c. **TRAUMATIC DISLOCATIONS.**—I. **Dislocation of the Lens into the Anterior Chamber** may occur as the result of an injury, such as a blow on the eye, or on the head in the vicinity of the eye. Occasionally it is caused by excessive retching or coughing, but in such cases it will generally be found on inquiry that the eyes were unsound and pre-disposed to this accident.

Symptoms.—A transparent lens lying in its capsule in the anterior chamber presents a peculiar and characteristic appearance. It looks

like a large drop of oil lying at the back of the cornea, the margin of the lens exhibiting a brilliant yellow reflex. The iris is pushed backwards, and the anterior chamber is thus greatly deepened. The pupil is always more or less dilated, partly probably from the injury to the ciliary nerves and body, but partly also from the pressure of the lens upon the iris. The lens in this abnormal position generally acts as a foreign body. It is productive of great irritation and of severe pain, which is often neuralgic in character, from pressure on the iris and ciliary nerves. The inflammation which so frequently follows this accident may be partially due to other parts of the eye having suffered from the primary injury; but much must also be attributed to the pressure of the lens on the iris.

Treatment.—If the lens is giving rise to irritation, it should undoubtedly be removed, and as soon as possible; the irritation will probably continue and increase if it is allowed to remain in its abnormal position. But if the lens, although lying in the anterior chamber, is not acting as an irritant, and the eye, when seen by the surgeon, is perfectly quiet and free from undue vascularity, what course should be pursued? To answer this question, it is necessary to consider what are likely to be the ultimate effects of such an accident. Now, although the eye when first seen may be quiet and free from all vascular excitement, yet it is impossible to say how long this quiescent state may last. In the first place, an outbreak of acute inflammation may occur at any time without any especial assignable cause beyond the abnormal pressure of the lens on the iris. Again, this pressure upon the iris is very apt to give rise to a glaucomatous state, under which the tension of the globe becomes suddenly increased, and the pain very severe. This condition is always one of peculiar danger to the eye, and calls at once for active treatment. Lastly, from the same cause, paralysis and atrophy of the iris may slowly supervene.

Considering, then, the many casualties which may happen to an eye with a dislocated lens lying in its anterior chamber, it is advisable in all cases to remove it.

In children a linear extraction may be performed. It is generally judicious in such cases to complete the extraction of the lens in one sitting rather than to divide it into two stages, with an interval of some days between them, as in the ordinary mode of performing suction and linear extraction operations.

If the patient be an adult or a person advanced in years, the dislocated lens should be removed through a section in the margin of the cornea, its exit being assisted with a cataract spoon. Having made the section in the corneo-sclerotic junction with a Graefe's cataract knife, and if possible excised a portion of the iris, the lens should be taken away *in* its capsule with the aid of a cataract spoon (Fig. 136), or with a sharp hook, which may be made to seize hold of it and draw it from the eye. During the operation an escape of vitreous will probably occur, as the suspensory ligament must have been torn to allow of the lens being dislocated, and this could hardly have been accomplished without at the same time some rupture of the hyaloid membrane.

2. **Dislocation of the Lens into the Vitreous.**—This accident may occur either with or without rupture of the external coats of the eye.

The lens is usually dislocated enclosed in its capsule, which may be either entire or partially lacerated. If the capsule has been torn, the lens will soon become cataractous; but even if it is entire, the lens after some months generally becomes opaque on account of the interference with its nutrition.

If the dislocation has been *complete*, the iris, having lost the support of the lens, will fall slightly backwards towards the vitreous, and thus increase the depth of the anterior chamber. The iris will also be found tremulous, its whole surface vibrating with the movements of the eye; whilst the pupil is always more or less dilated.

Usually, however, some shreds of the suspensory ligament still remain connecting the lens and capsule with the upper region of the globe; in which case the lower edge of the lens will press the lower segment of the iris forwards, whilst the upper portion of the iris will be displaced backwards from loss of support.

The symptoms are those of great irritation. There is increased vascularity, with dread of light, lacrymation, and pain. The eye, from the first effects of the injury, becomes actively inflamed, but this state under treatment may gradually subside. It is, however, generally succeeded by a low form of choroido-iritis or choroido-retinitis, which is kept up by the irritation caused by the abnormal position of the lens. In this stage glaucoma frequently supervenes, and the tension of the eye becomes greatly increased. With the increase of tension all the symptoms become aggravated; and unless the lens—the source of the irritation—is removed, the loss of the eye is certain. This glaucomatous condition is liable to occur in all the dislocations of the lens *within* the eye, but it is more prone to follow those in which the lens is either partially or completely displaced behind the iris, than when it is thrown in front of that structure.

Treatment.—If the dislocation is complete, and the eye is free from irritation, it should be left alone, but the patient should be kept under careful supervision. If, however, the displaced lens is exciting inflammation, it should be removed. No speculum should be used, as its pressure on the eye favours the escape of vitreous. The upper lid should be raised with a retractor, or by the index finger of the operator, whilst the section is made in the margin of the cornea with a Graefe's knife, as in the cataract-extraction operation (page 269). It is often impossible to seize hold of the iris to draw it out of the wound preparatory to excising a portion of it; for, having lost the support of the lens, it will sometimes fall backwards and get so behind the cut edge of the sclerotic that the forceps cannot be made to grasp it. This difficulty is increased by an escape of vitreous, which almost invariably takes place immediately on the withdrawal of the knife from the eye, and is dependent on a rupture of the hyaloid at the time of the accident, which has allowed the vitreous to fall forwards. If, therefore, the attempt to seize and draw out a piece of iris is unsuccessful, it is better at once to pass the spoon through the pupil to the back of the lens, and to draw it out, if possible, in its capsule.

3. **Dislocation of the Lens beneath the Conjunctiva** can only occur in cases where the sclerotic has been ruptured, whilst the conjunctiva over the rent has remained entire. The lens, separated by the violence of the injury from its ciliary attachment, is forced out of the eye through the wound, and as the conjunctiva has not been lacerated, it will be seen lying beneath it. The dislocation is almost invariably upwards, or upwards and inwards, because the blow must strike the eye from the outer side or below, causing a split in the sclera in the upper regions of the eye between the insertion of the recti muscles and the margin of the cornea. The eye is sufficiently protected by the orbital arch and nose from blows coming from other directions of such a nature as to cause this accident.

Symptoms.—The lens will be seen lying beneath the conjunctiva, forming a small, rounded, semi-transparent swelling. If the anterior chamber is clear, the altered shape of the pupil, probably also the tremulous state of the iris, and the presence of a subconjunctival tumour, will be sufficient evidence of the nature of the accident. The lens is nearly always dislocated enclosed in its capsule; but, owing to the rough manner in which it is squeezed through the aperture in the sclerotic, the capsule is often lacerated, and the lenticular matter frequently somewhat comminuted.

Treatment.—When the lens is seen lying beneath the conjunctiva, it should be removed. This may be done by making a small incision through the conjunctiva either with a cataract knife or with a pair of fine scissors, and then, if the lens is entire in its capsule, by at once lifting it out. If its capsule has been broken and its substance comminuted, it should be carefully removed piecemeal with a small scoop, paying special regard that fragments of it are not left between the lips of the wound in the sclerotic to interfere with its primary union. The lids should be then closed, and a compress with a light bandage be applied to the eye.

It will be well, as a precautionary measure, to apply two or three leeches to the temple, and for a few days to keep the patient on a slightly antiphlogistic regimen.

PARTIAL TRAUMATIC DISLOCATION OR SUBLUXATION OF THE LENS may occur from blows on the eye or the side of the head, when a portion only of the suspensory ligament is detached, and consequently a limited or only partial displacement of the lens ensues.

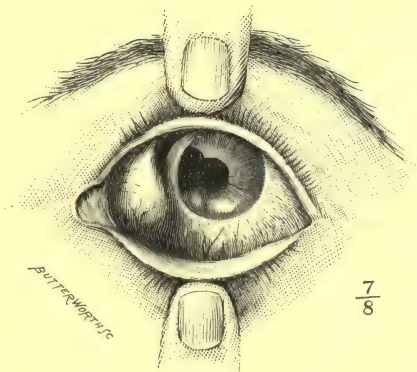


FIG. 140.—Subconjunctival dislocation of the lens. The lens has torn away a portion of the iris, and is seen on the inner side protruding beneath the conjunctiva.

1. The lens may be luxated in any direction, and remain permanently fixed in its new position.

2. Occasionally the lens is found to be slightly tilted without any absolute displacement; one margin is pressed forwards against the iris, whilst the other is forced back into the vitreous.

3. The suspensory ligament may have been torn or partially detached at one part of its circumference; and although no immediate displacement of the lens may have followed, yet, owing to this loosening or partial detachment of its ligament, it may have become what is called a *movable or swinging lens*, swaying backwards and forwards with the movements of the head or the eye. In certain postures of the head, as in looking downwards or in stooping forwards, a partial dislocation of the lens through the pupil may take place; whilst with the head erect, as in looking directly forwards or upwards, the lens may sink back behind the pupil to apparently its normal position. Independently of the intra-ocular symptoms which such a swinging lens is liable to excite, a serious defect in vision will be produced by the frequent changes in the position of the lens, which render the eye not only comparatively useless, but may prove a source of very considerable annoyance and even danger to the patient, by producing monocular diplopia and causing him to misjudge and confuse objects with which he may come in contact in his daily work.

Symptoms.—Partial displacements of the lens are generally accompanied by grave symptoms similar to those described in treating of

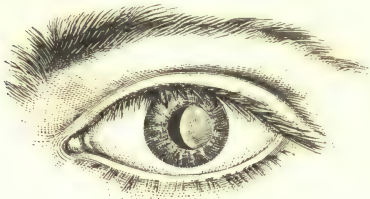


FIG. 141.—Partial dislocation of the lens into the anterior chamber. In the case from which this drawing was made the lens could be seen to vibrate on movements of the head.

complete dislocations, and, as in the latter, glaucoma is the complication most to be feared. If it be a swinging lens, the glaucoma is apt to be more or less recurrent, increasing or subsiding according to the position of the lens and its pressure upon the iris at different times. A frequent repetition of glaucomatous attacks will, however, speedily induce such changes that total loss of sight will ensue unless active measures are undertaken. The lens may remain transparent for a long time after the

injury, but the general rule is for it sooner or later to become cataractous. When the subluxation is so directed that a clear portion of the pupil is left aphakic, a troublesome monocular diplopia is liable to be produced so long as the lens remains transparent.

Treatment.—At first, attempts must be made to soothe the general inflammation following the accident by ordinary antiphlogistic means, and if the eye quiets down, some benefit may subsequently be received by glasses. If we have to deal with a swinging lens, which frequently drops partially through the pupil and confuses vision, its extraction may be advised, even though there be no pain or increase of tension. The advent of glaucoma demands immediate operation to remove the lens; and this should be effected through a corneal incision, made, if

possible, to correspond with the edge of the lens which is most anterior. The lens should be withdrawn with a cataract spoon, and vitreous will probably be lost from rupture of the hyaloid membrane at the time of the accident. If the lens is very movable, it may be steadied by transfixing it with a needle passed through the cornea prior to making the incision, and thus it may be held in position until the lens scoop has been passed behind it.

APHAKIA, OR ABSENCE OF THE LENS, AND ITS CORRECTION.

Congenital absence of the lens has already been mentioned (see page 251). The eye in this case is always blind, and consequently the consideration of aphakia is only of practical importance when the lens has been removed by operation or injury.

In the emmetropic eye the *static* value of the lens may be regarded as equivalent to a convex lens of + 10 D, and the placing of such a lens before the aphakic eye should restore the distant vision, provided that no capsular opacity or disease of the vitreous or fundus of the eye is present.

In a hypermetropic eye the value of pre-existing H must be added to this lens, so that a hypermetrope of 4 D will require a lens of + 14 D to give the best results.

In patients slightly myopic a similar *deduction* from + 10 D will have to be made, but when the M is of high degree this method of calculation cannot be sustained; for it is found by experience that the loss in refraction after removal of the lens is usually much greater than that occurring in emmetropia and hypermetropia, so that in a pre-existing M of 20 D it is possible that emmetropia will only just be reached (see also "Myopia," page 71).

To replace the *dynamic* value of the lens, a convex glass of + 4 D to + 6 D will need to be added to that required for distant vision, the exact power depending on the distance at which the patient likes to read or work.

In addition, the healing of the wound after a corneal section has been made is generally followed by a certain amount of flattening of the vertical corneal meridian. This will show itself by the presence of some astigmatism, which rarely exceeds + 2 D, and is corrected by adding the suitable cylinder to the distance and reading glasses, with its axis placed horizontally or inclined slightly to one or the other side.

After a successful extraction of cataract a patient may thus be enabled to read Snellen's types $\frac{6}{6}$, and Jaeger No. 1; but in many cases, from one cause or another, we are obliged to be content with a somewhat less brilliant result than this.

It will be understood that aphakic patients can only see distinctly objects for which their glasses are focussed,—that is, objects at a distance of twenty feet or more with their distance glasses, and those quite close at hand with their reading glasses. Thus objects situated at intermediate distances, such as stairs, etc., give aphakic patients much trouble, and are at first a constant source of complaint; because their reading glasses are too strong, and their distance glasses

too weak to see such objects distinctly. In course of time experience will come to the aid of the patient, and he will acquire by the general appearance or outline of such objects the information necessary to avoid danger, etc.; and, further, we may help him by prescribing glasses about + 2 D to + 3 D stronger than the distance glasses, which he may hold up in front of the latter when required. In some cases, however, we shall find that the patient by pulling the distance glasses somewhat down on the nose will gain the same benefit as by these intermediate glasses, and, if this is so, the latter may be dispensed with. The optical effect of increasing the distance of a convex lens from the eye will be understood by referring to page 52.

Another point is, that when a patient looks for the first time through lenses correcting the aphakia, the result of operation may be disappointing, though we can find no reason for the poor vision obtained. The fact is that aphakic patients have often, as it were, *to learn to see again*, and the surgeon will frequently be gratified to find, after the glasses have been worn for a month or so, that the vision has greatly improved from that obtained at the first trial.

A curious phenomenon sometimes observed in aphakia is that of coloured vision. It generally comes on shortly after extraction, and most commonly takes the form of colouring all objects red (erythropsia), though blue vision has also been described in a few cases. No entirely satisfactory explanation has yet been offered of the phenomenon; but it is satisfactory to note that the coloured vision tends to gradually disappear within the course of a few weeks.

CHAPTER XVIII.

DISEASES OF THE VITREOUS.

ANATOMY.—The vitreous chamber occupies about four-fifths of the interior of the globe. The vitreous humour is a transparent jelly-like substance with a refractive index slightly greater than distilled water, and containing about 2 per cent. of solids composed of a trace of albumen together with a small quantity of the chloride and carbonate of sodium. The structural elements of the vitreous are very few, and consist of a very delicate fibrillar reticulum, in which are scattered a few cells of a connective-tissue type which are difficult to recognise, and are known as the *vitreous corpuscles*. In addition, it sometimes contains a certain number of migratory leucocytes, to the presence of which the subjective symptoms caused by “*muscæ volitantes*” (see page 293) may be sometimes due. The vitreous is enclosed in a delicate structureless envelope known as the *hyaloid membrane*, which lies in close apposition with the pars ciliaris retinæ and retina proper. At the site of the optic papilla the union is more firm than elsewhere; for at this spot, in foetal life, the hyaloid branch of the central retinal artery passed forwards through the vitreous to the back of the lens (see “Development”). The artery disappears before birth; but its containing canal, known as the *canal of Stilling or Cloquet*, persists in after-life as a lymph channel. Anteriorly, the vitreous is hollowed out into a shallow depression, known as the *Fossa Patellaris*, into which the back of the crystalline lens is received, and in this situation the presence of a definite hyaloid membrane has been much disputed. Some anatomists regard the hyaloid as ending altogether in the suspensory ligament of the lens; others, and this is the more generally accepted view, assert that the hyaloid splits into two layers, one of which helps in the formation of the suspensory ligament, whilst the other is continued over the anterior face of the vitreous as an exceedingly attenuated covering. The vitreous is avascular, and depends for its nutrition on the blood-vessels of the uveal tract, and partly perhaps upon the nutritional fluid secreted by the glandular crypts of the ciliary processes.

Unlike the aqueous, fresh vitreous is never generated. A loss of vitreous occasioned by a penetrating wound is rapidly replaced by aqueous. If the amount lost be small, no ill-effects may follow, as sufficient aqueous will be kept secreted to supply its place; but if the escape of vitreous is large, the eye usually suffers. For a time the aqueous fills out the globe; but the supply after a time fails to meet the demand, and the eye first becomes soft, then shrinks, and ultimately all sight is destroyed.

CONGENITAL ABNORMALITIES.

Persistent Hyaloid Artery.—The hyaloid artery, or perhaps more commonly its sheath, may persist after foetal life. In rare cases a portion of the artery near the disc may remain patent, and a pulsating stump may be seen projecting into the vitreous; and still more rarely the blood-column may be traced as far forwards as the lens, in which case there must necessarily be also present some remnants of the fibro-vascular sheath which covers the back of the lens in foetal life.

The most usual appearance is that of a greyish tag or strand connecting the optic papilla to the posterior pole of the lens, its point of attachment to the latter being marked by a small opacity; or the strand may be attached by one end only, whilst the other is free, and can be traced for a variable distance in the vitreous. The vision is not necessarily affected, unless there be a large opacity at the posterior pole of the lens; but these eyes are often amblyopic and ill-developed, and not infrequently definitely microphthalmic.

Congenital Fibrous Membranes.—Occasionally it happens that in addition to remnants of the hyaloid artery other evidence of ill-development of the vitreous is shown by the presence of bands or agglomerations of fibrous tissue. Such eyes are usually microphthalmic.

OPACITIES IN THE VITREOUS.

* These may be either (1) Exudations into the vitreous or a metamorphosis of the vitreous elements secondary to disease of the uveal tract, which may be conveniently classified under the heading of *Hyalitis*; (2) Particles of blood-clot; (3) the so-called "*Muscae Volitantes*."

1. **HYALITIS**, or inflammation of the vitreous, is a term scarcely justified pathologically, as the avascular and almost structureless nature of the vitreous renders it incapable of being *inflamed* in the ordinary acceptance of the term. It is, however, useful in the sense above alluded to, and in this sense hyalitis may be classed as (a) *suppurative hyalitis*, and (b) *non-suppurative hyalitis*.

a. **Suppurative hyalitis** is encountered in panophthalmitis, or suppurative inflammation of the globe. The purulent infection in

these cases is recognised by the dull yellow reflex from the pupil. In very acute cases the vitreous may be infiltrated with pus in the course of a few hours, and when this has taken place the eye is irretrievably lost. The condition is further discussed in the section dealing with panophthalmitis.

b. Non-suppurative hyalitis occurs as a complication of diseases of the ciliary body, choroid, or retina, and is especially frequent in those that have a syphilitic origin; or it may follow the lodgment of a foreign body in the vitreous or an injury of the uveal tract. The vitreous presents a diffused haziness, with here and there filmy opacities consisting of particles of exudation or of effused lymph, which assume a variety of forms, resembling either grains of soot, dark threads, or membranous expansions. Sometimes the opacities are so fine and dustlike as to scarcely interfere with the transparency of the vitreous, and are only to be discovered by careful examination. In other cases, especially when due to the presence of a foreign body within the eye, large masses of lymph will be frequently seen behind the edge of the lens, projecting into the vitreous, whilst the rest of its structure is so turbid as to exclude the fundus of the eye from ophthalmoscopic view. Or, lastly, in cases, usually of long-standing, where partial absorption has taken place, opacities may exist in considerable numbers, whilst the vitreous as a whole forms a perfectly clear medium.

When the opacities are numerous, there is usually great impairment of vision; but this is often as much due to the disease which has led to their formation as to the impediment they offer to the passage of light to the retina. Those which are placed deeply in the vitreous create the most confusion by throwing their shadows on to the retina.

Diagnosis.—Large opacities in the vitreous are easily seen with the ophthalmoscope by the direct method with a convex lens of + 3 D to + 8 D behind the mirror. They are most readily detected by directing the patient to move his head in various directions, when they will be seen to float before the pupil. They are distinguished from opacities of the lens and cornea by their depth and mobility, whilst they cannot be discerned by focal illumination, as can all opacities in the cornea and most opacities in the lens. Fine dustlike opacities are often difficult to make out, and they are best distinguished by using low illumination and a plane mirror with a low convex lens (+ 3 D to + 6 D) behind it.

Prognosis.—When the infiltration is slight and recent, the opacities may disappear and the vitreous regain its former transparency, but in severe cases only partial absorption is to be expected under the most favourable circumstances.

In any long-standing or severe inflammation the nutrition of the vitreous becomes seriously impaired. It first loses its consistency and becomes more or less fluid, following which comes a reduction in its bulk and a diminished tension of the globe. In the worst cases this shrinking progresses, and the vitreous separates away from the retina, or, as it is sometimes expressed, the vitreous becomes *detached*; though it must be remembered that the vitreous is nowhere attached to the

retina, but only lies in close contact with it. The retina in such a case, losing the support of the vitreous, generally likewise becomes wholly detached or *co-arct*, and its separation once begun is hastened by serous exudation from the choroidal vessels, which gradually occupies the greater part of the post-lenticular space. The sight is of course hopelessly lost, and these degenerative processes are followed by an increasing softening and shrinking of the globe, or *phthisis bulbi* (see Fig. 106).

Treatment.—Opacities of the vitreous must be treated by attacking the disease which has given rise to them. Those which have a syphilitic origin and are dependent on small plastic effusions are more amenable to remedies than any of the other forms. In the course of time they will shrink considerably, and many of them will disappear from the field of vision. The dense membranous opacities which greatly obstruct vision by floating in front of the object, von Graefe treated successfully by dividing with a fine needle, as in a capsular operation after cataract.

2. HÆMORRHAGE INTO THE VITREOUS.—This may take place—(1) from rupture of some of the vessels of the ciliary processes; (2) from choroidal hæmorrhage, the blood breaking through the retina and becoming extravasated into the vitreous; or (3) it may ensue from the rupture of a retinal vessel.

Blood effused into the vitreous is but slowly absorbed. If the clot be small, it gradually loses its colouring matter, and shrinks, and after a few weeks or months it is seen with the ophthalmoscope either as a small dark mass, or as floating filaments in the vitreous. If, however, there has been much hæmorrhage, loss of the eye is certain to follow. To allow the blood to be extravasated, the hyaloid has to be ruptured, and wherever the blood forces its way, it breaks down the texture of the vitreous. From this mutilation of structure the vitreous does not recover; it atrophies, loses its consistence, and becomes fluid. The blood-clot softens and is gradually dissolved, and its colouring matter stains the whole of the fluid which occupies the vitreous space to a yellow or brownish-yellow tinge, which colour may last for years. The mischief, however, does not end here, for, as the vitreous becomes fluid, it diminishes in bulk, and the retina, losing the support which it had received from the healthy vitreous, falls forward and becomes detached.

Treatment.—Rest to the eyes by abstaining from reading or close work, and the avoiding of stooping positions are important points. If there be pain, weak atropine may be used, and a fold of lint wet with some cold soothing lotion, such as the Lot. Belladonnæ (F. 41) or the Lot. Opii (F. 48), may be laid over the closed lids. Internally a mixture containing the liquid extract of ergot or iron alum may be given twice a day and continued for some weeks. The bowels should be kept acting regularly, and a saline purgative given once or twice in the week if there be any tendency to constipation.

3. MUSCÆ VOLITANTES.—Opacities of the vitreous, the result of

disease, must be distinguished from the motes or *muscæ volitantes*, which are perfectly compatible with healthy eyes, although they are the source of much anxiety, and even of misery to the patient. Two varieties of *muscæ*—the *transparent* and the *opaque*—are commonly met with—and they occur mostly amongst myopic patients and those who much use their eyes for fine or close work.

The transparent *muscæ* are best seen when looking up in the light or against a white surface, either through a small aperture in a card, or with the lids partially closed. They consist of numerous small, transparent, bead-like bodies, some of them hanging together in rows or in clusters, whilst others are floating as isolated circles in myriads before the eye. They do not obscure vision, as everything is seen clearly through them, or by their side. If the eyes are suddenly turned upwards and then fixed, they will be observed by the patient to float slowly downwards, as if gravitating to the fundus of the globe. They are perfectly innocuous, and merely represent the corpuscles of the vitreous or the *débris* of migratory leucocytes, which in certain lights become obvious to the eye in which they exist. The different shapes assumed by these transparent *muscæ* are caused by aggregations of the corpuscles either into groups or strings.

Opaque *Muscæ*.—The second form of mote, which is often complained of, consists of one or more dark spots of different fantastic shapes, which are constantly floating before the field of vision, and shifting with the movements of the eye. They will appear suddenly and remain for years without increasing or diminishing, or without the eye becoming in any other way affected. They will also disappear occasionally for months or longer, and then turn up again in their old familiar form. This, perhaps, may be explained by supposing that the body of which the mote is composed floated out of, and was for a time accidentally kept from, the field of vision, when, again becoming free, it reappeared. The cause of these opaque *muscæ* it is difficult to ascertain. They may be the *débris* of cells congregated together, or opaque detached filaments from the supporting reticulum of the vitreous, or a little of the uveal pigment which has been accidentally detached from the ciliary processes and has worked its way into the vitreous.

Treatment.—Rest the eyes by abstaining from all close work, and avoid constantly looking for the *muscæ*. If in bright lights they become visible without the patient searching for them, he should be provided with neutral tint or dark cobalt-blue glasses. Tonics of quinine or iron frequently do good by improving the health and rendering the eye and the mind of the sufferer less impressionable to little defects. No local applications will be of any service for the purpose of getting rid of true *muscæ volitantes*. The patient should be assured that they are not portentous of coming blindness, and that they may continue for years without causing any more than their present annoyance.

Muscæ must not be confounded with *scotomata*, which are fixed blind spots in the field of vision, dependent on a loss of sensibility of a portion of the retina.

FLUIDITY OF THE VITREOUS—SYNCHISIS.

a. As a Result of Inflammatory Disease.—Fluidity of the vitreous is the beginning of the end of many of the diseases of the eye which lead to blindness. It may be due to inflammation of the iris, ciliary body, choroid, or retina. It is one of the terminations of sympathetic ophthalmitis, and is a frequent result of injuries of the eye accompanied by deep or posterior intra-ocular hæmorrhage. It also usually occurs in hydrophthalmos, and in most cases of general staphylomatous enlargement of the globe. In many diseases, fluidity of the vitreous with softening of the eye follows increased tension; it is so in sympathetic ophthalmitis, and in cyclitis, and frequently also in glaucoma. It then indicates that the disease has done its worst, and atrophy of the tissues within the eye has commenced.

A fluid vitreous does not necessarily imply a soft eye; the globe may in certain cases be of its normal tension, or it may be even glaucomatous, and have its hardness increased. A soft eye, however, usually indicates a fluid vitreous, unless the diminution of tension has been caused by a recent escape of vitreous from an injury.

b. From Trophic Causes.—Although fluidity of the vitreous is commonly produced by some inflammatory disease, yet it may occur in eyes that have never suffered from an inflammatory affection, and in which it may be impossible to assign a definite cause. In such cases the fluidity of the vitreous is only one of other signs of defective nutrition. The patient is often young, and both eyes are generally affected. Without apparent cause, opacities appear at the posterior pole of the lens, which gradually involve its whole structure, whilst the vitreous becomes fluid, reduced in bulk, and the tension of the globe diminished. Following these changes the retina may become detached, and the eye irretrievably lost.

c. Sparkling Synchisis—Synchisis Scintillans.—These euphonious titles have been given to the beautiful appearance which is presented by sparkling flakes of cholesterine floating in a fluid vitreous. They frequently abound in such quantities that they may be seen to descend in a perfect shower after every movement of the eye. With the ophthalmoscope, the crystals of cholesterine look like chips of gold leaf, and make the vitreous closely resemble the liqueur called gold-water. The cholesterine is probably derived from blood which at some distant period had been effused into the vitreous.

PARASITES IN THE VITREOUS.

Parasitic cysts in the vitreous are very rare. They are never primarily situated in the vitreous, but spread into it from the retina or choroid. In almost every case the parasite has been the *Cysticercus cellulosæ*, or cystic form of the *Tania solium*.

Diagnosis.—Unless the nature of the disease had been previously determined when the cyst was contained by the retina, a positive

diagnosis will probably be impossible, owing to a general turbidity of the vitreous.

Treatment.—Invasion of the vitreous implies that the eye is hopelessly lost, and nothing remains but enucleation (*see also* “Cysticercus of the Retina”).

INTRA-OCULAR TUMOURS frequently extend into the vitreous, and in glioma it is almost invariably the yellowish reflex from the infiltrated vitreous that brings the case first under the surgeon's notice.

Vascular Connective Tissue in the Vitreous.—(*See* “Retinitis Proliferans.”)

Foreign Bodies in the Vitreous.—(*See* “Foreign Bodies within the Eye.”)

CHAPTER XIX.

SPECIAL INJURIES OF THE EYE AND THEIR TREATMENT, INCLUDING ENUCLEATION OF THE GLOBE AND THE OPERATIONS THAT MAY BE SUBSTITUTED FOR ENUCLEATION.

FOREIGN BODIES WITHIN THE EYE.

THE lodgment of a foreign body within the eye is one of the most serious injuries which can happen to that organ, and the importance of ascertaining correctly, as soon as possible after the infliction of an injury, whether there is a foreign body within it cannot be overestimated. The prognosis of the case rests entirely on the elucidation of this one point.

Every penetrating wound of the globe should be specially examined with reference to the possibility of there being a foreign body within the eye.

The dangers of a foreign body within the eye are—

1. The risk of the eye being completely destroyed by the inflammation which its presence may excite.
2. If the eye has been destroyed by the inflammatory action which the foreign body has induced, the stump, or that which remains of the eye, will be liable to repeated attacks of inflammation so long as the foreign body continues embedded in it; and with each attack there will be an increased danger of the other eye becoming affected with sympathetic ophthalmitis.

Simple examination by the X rays is of little use in ophthalmic surgery, for although a skiagraph will reveal the presence of a foreign body, it will only show it as present in the orbit without any reference to its position as regards the globe or its component parts. Mackenzie Davidson has, however, invented a most ingenious apparatus by which the position of the revealed foreign body with regard to the eye is measured and localised to a nicety. Under these conditions the X rays have proved a very great boon, and all cases, in which there is any doubt

as to the position or presence of a foreign body within the eye, should be submitted to an investigation of this kind.

Suspicion of a foreign body should be entertained when, after a history of injury, a wound either fails to close or only does so partially; when there has been much intra-ocular hæmorrhage; when there is persistent irritation, with subacute irido-cyclitis or choroido-retinitis; and when there is severe and continued pain.

The Localisation of Foreign Bodies by the X rays according to Mackenzie Davidson's Method.—To fully grasp the technical details, a practical acquaintance with the apparatus is essential, but the following description* will serve to explain its salient features.

Before proceeding to the description, three points should be noted:

In the first place the necessary stereoscopic picture of the foreign body is obtained by taking two skiagraphs from two different points of view. The essential geometrical relations of these skiagraphs to each other are maintained by fixing the head and by taking each skiagraph with the Crook's tube displaced 3 cm. horizontally, first to one side and then to the other, of a known point of reference on the skin. The latter is furnished by the intersection of two cross-wires, which will leave a corresponding shadow on the negative, and against which the side of the head to be skiagraphed is placed.

Secondly, Mackenzie Davidson employs an "*Osmium*" anode, by which the very fine particles of steel, etc., which are so often found in the eye are much better defined than with the ordinary platinum anode.

Thirdly, it is to be remembered that the X rays always travel in straight lines from their origin at the anode of the Crook's tube to their destination on the photographic plate. Advantage is taken of this fact when measuring the position of the foreign body from the skiagraphs, to trace the direction of an X ray by means of a fine thread.

Description of the Method.—The patient is seated upright on a chair which supports his back, and the head is fixed in a specially devised frame. The weight of the head is supported by a projecting chin-rest, and the side of the head to be skiagraphed is placed against two crossed wires which are tightly stretched across an open space on one side of the frame. This space is large enough to admit the photographic plate, and a hinged door allows the plate and the wires to be pressed against the patient's temple. The other side of the head is compressed by a piece of wood which slides along a horizontal slot in the back-piece of the frame, and which is fixed in the desired position by means of a screw adjustment.

The patient, being so placed, is made to look at a small point some distance in front of him, which is situated so that the visual axis of the injured eye is parallel to the horizontal wire. The side of the patient's head is then marked with a pencil along the horizontal wire.

Then a small piece of lead wire (1 cm. in length) is fixed by means of adhesive plaster to the lower eyelid of the affected eye in such a way

* See 'Brit. Med. Journ.,' 1898, i, p. 10, and 'Trans. IX Internat. Ophthal. Congress,' Utrecht, 1899.

that the upper end of this wire occupies a known position in relation to the eyeball while the eye is resting in the position in which it is going to be photographed.

Before the patient's head is placed in the frame, the adjustment of the tube should be made. The tube-holder is attached to a triangular bar of wood which slides in a horizontal groove, accurately parallel to the horizontal wire. A small rifle sight placed on a level with the intersection of the cross-wires enables the glistening point on the Osmium anode from which the X rays originate, to be adjusted to a right angle with the point of intersection. The distance of the anode from the plate, which is usually 28 to 30 cm., is also noted.

The horizontal bar with the tube holder is then displaced 3 cm. to

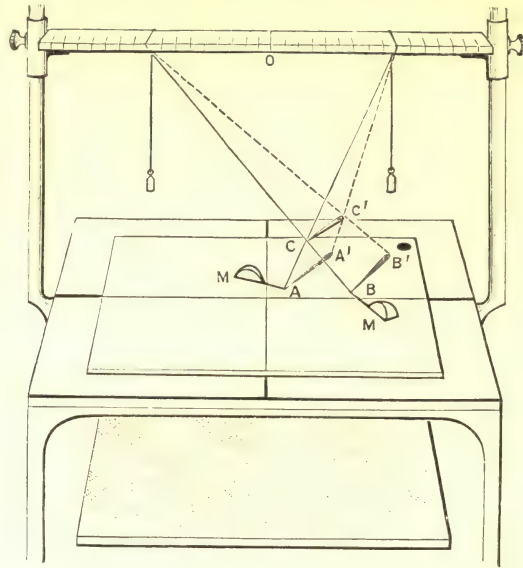


FIG. 142.—Mackenzie Davidson's "cross-thread localiser."

(A A') (B B') are the shadows of the foreign body, in this case a needle. (C C') is the representation of this body in space at the points of intersection of the cross-threads. (M M) Mouse-shaped weights attached to two fine needles. (For further explanation see page 299.)

one side of this position, and, the patient being told to look steadily at the fixation object, an exposure is made, which varies from 10 seconds to 1½ minutes at the most. Then the tube is displaced 6 cm. the other way by sliding the horizontal bar, and, a fresh plate having been inserted without the patient moving in any way, another exposure is made. The two negatives are then developed, and a tracing on a piece of celluloid of the known points and of any foreign bodies present is taken from each.

This tracing is then placed upon a glass plate in an apparatus which is called the "**Cross-thread Localiser.**" This is simply an apparatus for placing the negative in exactly the same geometrical conditions as those under which it was produced.

The localiser consists of an iron stand upon which a piece of plate glass, with two lines scratched upon its surface at right angles to each other, is placed horizontally. A mirror below can be adjusted to reflect light from beneath, and so make a negative visible when it is placed upon the glass stage. Above the glass there is a horizontal bar which slides up and down upon two vertical brass rods. On the bar there is a millimetre scale with a small notch at each millimetre mark, and having zero at the middle point of the bar. The glass plate is so arranged that the intersection of the cross-lines is vertically beneath the zero mark, and the horizontal of the two lines is parallel to the edge of the scale.

The negative is now placed on the glass plate in such a way that the shadows representing the cross-wires exactly coincide with the cross-lines on the plate, care being taken by previously marking a quadrant of the negative to see that it is placed in its correct position on the stage. The horizontal bar is then adjusted, so that the zero mark is exactly the same height above the negative as the anode of the Crook's tube was distant from the photographic plate.

The paths of the X Rays are now traced by means of two fine threads (see Note 3 on page 297), each of which is placed in the millimetre notch on either side of the zero mark corresponding to the lateral displacement of the Crook's tube when taking the skiagraphs. A small weight is attached to one end of each thread to keep

it taut, whilst the other end is threaded into a fine needle, which is also weighted (M M, Fig. 142). Now, looking at the celluloid tracing, we shall see the shadows of two foreign bodies (A A' B B'), that to the right being formed when the tube was displaced to the left, and *vice versa*. If, then, the right-hand needle is placed upon an extremity of the left-hand shadow (A), and the left-hand needle upon a corresponding point in the right-hand shadow (B), the threads will represent the paths of the X rays in each case, and the point where the threads cross each other (C) must fix the relative position in space of that part of the foreign body.

It will now be clear that all that remains to be done to localise the position of such a point is to measure the perpendicular distance of the intersection from three planes, which are at right angles to each other.

Firstly, we measure the vertical distance of the intersection from the negative, and this represents the depth of this point of the foreign body from the skin surface. This is easily estimated by a pair of compasses.

Secondly, we measure the vertical distances from the two vertical planes, represented by the shadows of the cross-wires, to the point where

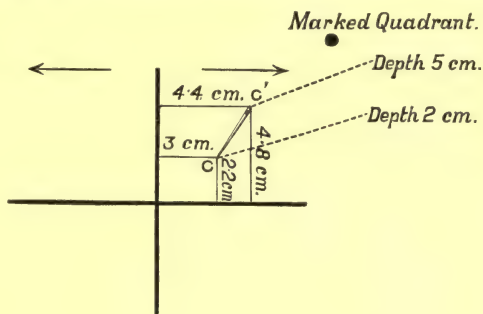


FIG. 143.—Diagrammatic chart to explain how the localisation and measurements of the foreign body (C C') are calculated after its projection in space by the cross-thread localiser. (See also Text.)

the threads cross. To do this, an upright square is placed with its edge coincident with the shadow of one of the wires, and the perpendicular distance is measured with compasses from it to the point of intersection. These measurements will give us a point on the skin surface directly beneath which that extremity of the foreign body lies. Having thus obtained the exact position of one extremity of the foreign body, the result is noted on a chart, as shown in Fig. 143, and we then proceed to a like examination of the other extremity of the foreign body. The relative positions and distances apart of these two points will give the position and actual length of the foreign body.

When dealing with an eye, however, we wish to know the position of the foreign body not as regards the lateral orbital wall, but as regards its relations to the anterior surface of the cornea. Hence the object of the lead wire attached to the lid, and the fixation of the eye when the skiagraphs are taken. When, therefore, the foreign body has been measured in the manner just described, similar calculations are applied to the upper end of the lead wire, and it then becomes a mere matter of simple subtraction or addition to find out the precise position of the foreign body with regard to the lead wire. Placing the patient facing the surgeon in the position in which he was skiagraphed, and looking in the same direction, the foreign body is then so many millimètres horizontally to nasal or temporal side of the upper end of the lead wire, and so many millimètres up or down, and, from the point thus estimated, so many millimètres backwards parallel to the visual axis.

It is as well to have a diagram of an emmetropic eyeball drawn to scale, and by means of it the exact position of the foreign body with reference to the various coats and media of the eye can be gauged to about one-fiftieth of an inch.

Lastly, it is important to realise that the skiagraphs taken in the way just described are really stereoscopic pictures, and when viewed in an ordinary stereoscope will give a picture in relief. Further, as the land-mark wire is of a known length (1 cm.), it can be used as a scale in the stereoscopic picture, and will enable the observer to estimate approximately the size and position of the foreign body by mere inspection.

Treatment of Foreign Bodies within the Eye.—Having satisfied ourselves that there is a foreign body within the eye, the undoubted treatment is to remove it, if practicable. But the object may be so placed that from its situation an attempt to remove it will incur a risk of loss of the eye, or from the difficulty of reaching it, the operation will probably fail. How, then, should we act? The answer to this is—

1. *If it is creating irritation, without hesitation endeavour to remove it.*

In all cases where the surgeon deems it right to attempt the removal of a foreign body from within the eye, he ought to have a discretionary power, that if he fail to find it, he may remove the globe *if circumstances render it advisable.*

2. *If the foreign body is creating no irritation, and there is a fair amount of vision, and an attempt to remove it would greatly hazard the eye—*even in such a case, provided the patient has a good second eye, an endeavour should be made to remove the foreign body; but if the injured eye is the only seeing one, no operation should be performed until symptoms of irritation arise.

In every case where the eye is destroyed for visual purposes by the inflammation induced by a penetrating wound and there is reason to believe that a foreign body is lodged within the globe, the only treatment to be adopted is to excise it. It has ceased to be an organ of vision, and at some future period it may, and very probably will, become a source of much danger to the sound eye.

The Extraction of Magnetisable Foreign Bodies from the Eye.—

The introduction of the electro-magnet into ophthalmic surgery has proved of enormous benefit, and by its means many eyes have been saved which would otherwise have been lost. For many years reliance had to be placed entirely upon hand magnets, and until Haab introduced his powerful instrument in 1894 (*see* Fig. 144) treatment was frequently handicapped for want of an instrument of sufficient attractive force to disentangle the small jagged particles or flakes of metal which form a large percentage of the foreign bodies that penetrate the globe.

The great objections to Haab's apparatus are that, owing to its large size and weight, it is a cumbersome and difficult instrument to manipulate, and for these reasons it cannot always be employed to the exclusion of the hand magnet, which must still be regarded as a most useful instrument.

If the foreign body is lying free in the anterior chamber, an incision should be made over it,—or in recent cases the corneal wound may be often utilised instead,—and the terminal of the hand magnet, which is detachable and should have been previously boiled, is then introduced, and the foreign body is usually easily withdrawn. If Haab's instrument is employed, the terminal, previously boiled as in the case of the hand magnet, is merely applied to the lips of the wound and not introduced.

If the particle is entangled in the iris or lens, the same method of procedure is followed; but in this case the hand magnet frequently fails to dislodge the foreign body. Should Haab's magnet also fail, it will be necessary to perform an iridectomy, which will include the body, or to extract the lens.

If the foreign body is in the vitreous, recourse should be had in the first instance to Haab's magnet, by means of which it may not infrequently be drawn into the anterior chamber, whence it can be removed

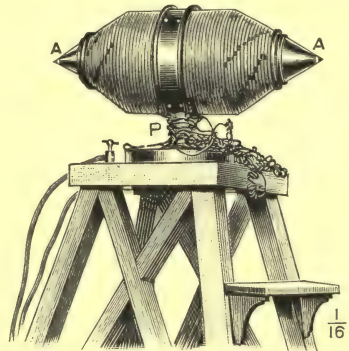


FIG. 144.—Haab's magnet.

(A A) Detachable terminals.
(P) Pivot upon which magnet can be made to revolve upon a vertical axis.

in the manner just described. Failing this, the magnet may drag the body so far forwards that it bulges the iris at one spot. In this case the application of the magnetic pole to the opposite side of the cornea may now cause the fragment to fly into the anterior chamber; but if not, the hand magnet may be tried through an incision over the site of bulging, and if both methods fail to disentangle the fragment, a piece of iris including the foreign body must be removed. Sometimes it happens that the fragment will bulge against the iris so long as the current is applied, but falls back again when it is switched off; and in this case it will be necessary to keep the current running whilst the removal of the particle is being carried out.

In a fair number of cases the Haab magnet will fail to move the foreign body sufficiently to effect its removal by a corneal incision, and when this is so, an attempt should be made to withdraw it through a scleral puncture, made at the nearest available point to the fragment. The puncture is best made with a Graefe knife, and must of course be large enough to allow of the exit of the particle. Its direction must be guided by the position of the fragment, and must follow a line calculated to effect its removal with the least possible disturbance of surrounding structures. The magnetic pole is then applied to the lips of the wound, and in many cases the foreign body will be drawn out. The sclerotic wound may then be united by one or two fine sutures, which should include the cut edges of the conjunctiva.

Failure to extract a foreign body will probably be due to one of two causes.

1. It may be embedded in the sclerotic far back, where it cannot be reached.

2. It may have been in the eye for a long time, and have become encapsuled in a firm sheath of organised inflammatory tissue.

To use the Haab magnet, the eye is cocainised, and the patient is seated in a chair. If this has a head-rest the magnet may be approximated to the eye, the patient meanwhile placing his head against the rest; or if there is no headpiece the patient leans forward and rests his elbows on the ledge of the frame carrying the magnet (Fig. 144), whilst the head, supported behind by the surgeon, is brought close to the magnetic pole, so that the latter as nearly as possible touches the eye without coming into actual contact with it. Care should be taken to adjust the magnet so that it exerts its force in the direction towards which it is desired to attract the foreign body.

When all is ready the *minimum* current is switched on and gradually increased until the patient begins to complain of pain. This indicates that actual traction on the foreign body is being exerted, and if with the maximum current no pain is experienced, it may be taken that the foreign body is non-magnetisable. As soon as pain is felt the current is maintained at that strength, so as to dislodge the foreign body as gently as possible; but if success does not follow, the current is gradually increased to the maximum. It is, then, often necessary to wait a minute or two and to apply the pole from two or three different directions before the foreign body makes its appearance. Sometimes the reversal of the current is of advantage, and it should

always be given one or two trials if the particle fails to become dislodged at the first attempt.

In no case should the *maximum* current be applied in the first instance, for such a proceeding is fraught with danger. In the first place, it may cause such a sudden pang of pain that the patient involuntarily jerks his head and perhaps knocks the eye against the magnet; and, secondly, if the foreign body happens to be near the surface and detached, it may suddenly tear its way out through the wound, and so be the means of exciting an inflammation which will endanger or destroy the eye.

MacCallan * has recently published a review of all the cases that have been submitted to the Haab magnet at the Royal London Ophthalmic Hospital up to July, 1901, and he shows that in 58 per cent. of the cases in which it was the means of removing foreign bodies from the vitreous chamber the eyes were saved, and that in half of these cases good vision was maintained. His tables also prove that much of this success depends upon the previous exact localisation of the foreign body, and therefore the use of the X rays can scarcely be over-estimated.

When the foreign body is non-magnetisable, attempts to remove it should be made on lines similar to those already detailed for magnetisable fragments; but if it be lodged in the vitreous chamber, the prospects of success are much diminished, and though an endeavour should be made by a well-judged incision through the sclerotic, failure will often result, and the eye will probably be lost.

INJURIES FROM GUNPOWDER, PERCUSSION CAPS, AND SHOT.

Gunpowder.—The near explosion of gunpowder may affect the eye in four different ways.

1. By the concussion it produces when exploded in close proximity to the eye. In this way a traumatic cataract may be produced, or the lens may be dislocated, or the retina may be detached.
2. From the burning or scorching of the surface of the eye and the lining membrane of the lids.
3. From depositing in the external tissues of the eye specks of unexploded powder.
4. From grains of powder being driven with sufficient force to penetrate the globe.

Treatment.—This consists in carefully removing all loose powder from the surface of the eye and conjunctival surface of the lids. Grains embedded in the cornea should be picked out, provided that they can easily be lifted away; but if they are lodged deeply they are best left alone. A little olive oil and cocaine should be then dropped into the eye, and a light dressing and bandage applied until irritation has subsided. Soothing lotions and weak atropine are the remedies upon which reliance should be placed if there is much photophobia and lachrymation.

* 'Roy. Lond. Ophth. Hosp. Rep.,' vol. xv, pt. ii, p. 156.

(For the treatment of injuries caused by concussion see "Traumatic Cataract," "Detachment of the Retina," etc.)

Injuries from Percussion Caps were formerly very common, but with improved modern appliances they are now comparatively rare. The injury is caused by fragments of the cap becoming detached when the cap is exploded, and as the eye is generally in close proximity, the violence with which such a fragment is driven against the globe is almost certain to cause penetration, and in nearly all cases the eye is irreparably lost. Fragments rarely fly off caps that are made with the best copper, but frequently will do so in cheap caps which are made of a brittle alloy, and are commonly used at fairs or sold for toy guns and pistols.

Treatment.—See "Treatment of Foreign Bodies within the Globe."

Injuries from Shot.—The velocity and direction of the shot when it strikes the eye determine very much the extent of the injury which it inflicts.

a. Spent shot may merely produce a slight concussion with ecchymosis of the conjunctiva, from which the eye may quickly recover.

b. Glancing Shot.—A shot travelling at full speed may strike the eye in its transit without penetrating it and leave a deep furrow, which may closely resemble a penetrating wound. The concussion of the eye thus caused may induce a detachment of the retina or set up a severe intra-ocular hæmorrhage.

c. Penetrating Shot.—As a rule, such irreparable damage is inflicted on the eye that all sight is at once extinguished. Acute inflammation sometimes accompanied by suppuration sets in; but generally the acute symptoms subside and are replaced by a low form of deep-seated irritation which ends in softening and shrinking of the globe.

d. The optic nerve may be wounded or severed by a shot without causing any injury to the globe itself.

Diagnosis.—In no class of cases has the X rays proved of more service than this. A shot may have penetrated the eye, but it may be, and often is, impossible to decide in any other way whether the shot remains in the eye or has made its exit at some unseen point. Or, again, a glancing shot may inflict such injury that it is only by means of the X rays that we can determine whether or no penetration of the globe has actually occurred.

Treatment.—The course of treatment to be adopted depends very much upon whether the shot is lodged in the globe. If it has completely traversed the eye or inflicted injury without penetrating, the eye may often be preserved, even though destroyed as a visual organ. If, however, the shot is located within the globe, an attempt should at once be made to remove it as described in the article on "*Foreign bodies within the Globe*," and if this fail the eye should be removed, as it will be a constant source of danger to the other. Of course an exception must be made to this rule if the injured eye is the only seeing one and there is still a little sight left.

INJURIES OF THE EYE FROM BURNS, SCALDS, AND ESCHAROTICS.

Quick lime, or lime before it has been slaked by the addition of water, is the most destructive agent that can come in contact with the surface of the eye. If it is in sufficient quantity and is allowed to remain long enough in apposition, absolute destruction of the part ensues, a slough follows, and complete loss of the eye is a not infrequent result. In the smallest quantity it is a most powerful irritant: a spasmodic contraction of the orbicularis tightly closes the lids upon the globe, and a copious flow of tears follows the introduction of even a particle of lime into the eye. The epithelium is at once whitened and destroyed, and a sharp clear line will indicate the boundary of the part which has been affected by the lime. Outside this boundary the conjunctiva is excessively red and more or less chemosed, and the lids, if the injury is severe, are œdematous.

If only the epithelium is destroyed it will be replaced, and no traces of the injury will remain; but it is seldom if ever that the action of unslaked lime is thus limited; the whole thickness of the tissue with which it comes in contact is usually destroyed by it, and dense contracted cicatrices are the result.

Mortar, Plaster, and the other combinations of lime used for building purposes differ only in degree from lime in the way in which they affect the eye. Their action is not quite so rapid or so acute as unslaked lime; still, if they are allowed to remain a sufficient time in contact with the eye or with the conjunctiva of the lids, similar results are produced; sloughs may be formed, and suppuration ending in complete destruction of the eye may follow.

Burns and Scalds of the Eye.—Hot fluids, according to the intensity of their heat, redden, vesicate, or even destroy the conjunctival surface of the eye or lids with which they come in contact. They produce the same immediate effect on the conjunctiva of the eye as they do on the skin covering the body; but the delicacy of the textures of the eye and the importance of the integrity of each for the well-being of the whole, render what would be a slight scald elsewhere a severe injury to the eye.

Strong Acids or Alkalis act chemically on the tissues of the eye, and if in sufficient quantity cause disorganisation of the parts with which they are brought in contact, producing superficial or deep sloughs.

The action of a strong acid or alkali on the eye, even in the smallest quantity, is that of a powerful irritant; it produces great pain and smarting, more or less œdema of the lids, and a constant flow of tears with intolerance of light, which may last for many days, even though the actual injury inflicted does not extend beneath the epithelium of the ocular conjunctiva.

The rapid flow of tears, however, which the irritation of the acid

or alkali instantly excites, quickly dilutes it; and if it is only a drop or a small splash which has entered the eye, the injury which it inflicts is comparatively slight and completely remediable.

Treatment of Injuries by Burns, Scalds, and Escharotics.—

Should the patient be seen within a very short time of an injury by an escharotic, and the means are at hand, the neutralisation of the acid or alkali should be at once effected by washing out the eye, in the case of a splash from an acid, with a weak solution of the bicarbonate of potassium or soda (grs. x ad ʒj); or in the case of an alkali, such as lime or caustic potash, with diluted vinegar or acetic acid, (mxxx ad ʒj). If, however, the patient is not seen within a few minutes of the accident, this treatment will be of no avail, and the best thing to do is to gently wash out the eye with a stream of warm water and then to place a drop or two of olive oil and cocaine (using a 2 per cent. solution) within the lids, and to cover the eye with a light aseptic dressing, smeared on its surface next the eye with a little atropine ointment, some of which will speedily find its way between the lids. The latter will do much to allay the pain, both as an emollient and also by relieving the spasm of the ciliary muscle which is always set up by the injury. In simple burns or scalds the treatment with olive oil and a dressing is sufficient without the irrigation.

When the injury is due to lime, mortar, or plaster, great care should be taken to remove every particle, and the eye should finally be gently irrigated to ensure the removal of any fine grains that have escaped notice.

If the lids are burnt or scalded, they should, in severe cases, be covered with a piece of lint soaked in the Lin: Calcis ē Creta (F. 32), or in equal parts of lime-water and olive oil (carron oil); but when the burn is superficial a little simple ointment will prove equally efficacious in relieving pain.

In all these different forms of injury the pupil should be kept dilated until all danger of iritis has passed, and, for the first few days, only soothing lotions should be employed, even if there be much reactionary discharge. Later on, if the inflammation tends to become chronic, weak astringents may be substituted, but it is best to avoid all powerful astringent applications, especially if there has been much sloughing, for fear of increasing the resultant cicatrices.

Opiates are often very useful in bad cases, not only because they relieve pain, but also because they seem to exercise a beneficial influence when there is much suppuration.

EXCISION OR ENUCLEATION OF THE EYE.

Instruments.—Fixation forceps (Fig. 132); blunt-pointed scissors, either straight (Fig. 193) or curved on the flat (Fig. 145); strabismus hook (Fig. 194); speculum (Fig. 130).

The surgeon should stand behind the patient for either eye.

With a pair of fine single-toothed dissecting forceps a fold of the conjunctiva and subjacent fascia is to be seized close to the cornea, and divided with a pair of blunt-pointed scissors, either straight or curved

on the flat. Through this opening, one blade of the scissors is to be passed, whilst the other remains external to the eye, and then, with a few clips, the conjunctiva and fascia covering the globe are to be cut through in a circle around the cornea. This division of the circumcorneal conjunctiva is most easily effected by commencing at the right-hand upper quadrant and first cutting round the cornea to the left, and then to the right, or *vice versâ*. A strabismus hook is then introduced beneath the tendons of each of the recti muscles, which are divided with the scissors close to their insertions in the sclerotic.

Having made certain that the recti muscles are completely divided, one finger of each hand should press back the tissues on either side of the eye, so as to push the globe forwards and partially dislocate it through the opening which was made in the conjunctiva at the commencement of the operation. By this simple manœuvre, the next step, the division of the optic nerve, is facilitated. The cut end of the tendon of either the internal or external rectus muscle should now be seized with the forceps, and the eye drawn over to one side, whilst the scissors, with the blades shut, are passed backwards between it and the surrounding tissues. As they round the posterior curve of the eye, the blades should be opened, when, after gently urging them a little further onwards, the optic nerve will come within their grasp, and may be then divided. The eye may now be lifted forwards with the fingers, and the oblique muscles or any other tissues which may be still adherent cut through with the scissors, and the operation will be completed.

When all the bleeding has ceased, the opening in the conjunctiva, through which the eye has been enucleated, may be closed by drawing the edges together with a fine suture, which is passed through them at different points and then tied. This is a finish to the operation, and gives an appearance of neatness to it at the time. It is not, however, essential, as the parts are afterwards completely drawn together by cicatrisation. In the excision of inflamed eyes it is positively prejudicial, as it prevents the free escape of inflammatory exudations, and thus favours orbital cellulitis.

In all cases where there is no external appearance to distinguish the diseased from the sound eye, it is the duty of the surgeon to

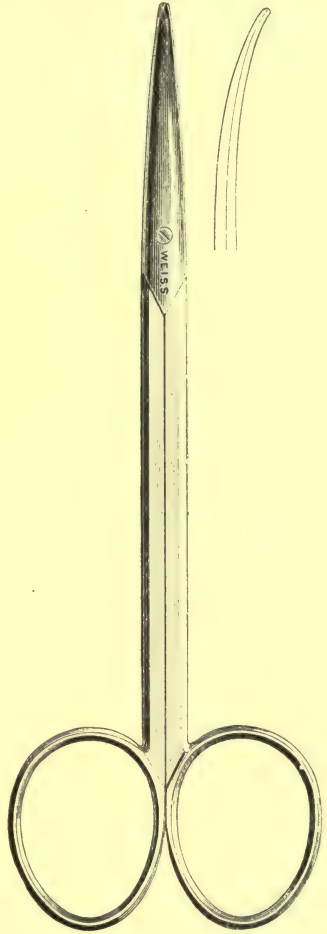


FIG. 145.—Blunt-pointed scissors, curved on the flat, very useful for division of the optic nerve.

indicate the eye which is to be excised by a mark over the brow before the patient is put under the anæsthetic. To remove the wrong eye is an accident which may occur unless proper precautions are taken.

Treatment after Excision of the Eye.—As a rule, the patient recovers so rapidly from this operation that but little after-treatment is required. No form of dressing is required, or should be placed between the lids. A pad of Gamgee tissue, smeared with a little of the Ung. Ac. Boric. to prevent it from sticking, and surmounted by a firmly applied bandage, is applied to the closed lids, and all discharge from the wound carefully washed away from time to time with a little warm boracic lotion gently syringed into the orbit with a glass syringe. The wound usually cicatrises in from three days to a week, but a slight muco-purulent discharge from the orbit often continues for two or three weeks afterwards. This may be checked by a lotion of Zinc or Hydrarg. Perchlor. (F. F. 54, 46), which should be used with a syringe two or three times daily. It frequently happens that on looking into the orbit the cause of the continuance of the discharge may be seen in a small fungoid granulation sprouting from the cicatrix of the conjunctiva. This should be removed by a single snip with a pair of curved scissors. There is little likelihood of such a granulation appearing if the cut edges of the conjunctiva have been united by a few points of suture as recommended above.

Of late years several suggestions have been made and carried out towards improving the technique of enucleation and increasing the mobility of the stump, by re-attaching the severed ends of the tendons so that they do not retract, as must necessarily be the case when enucleation is performed in the usual way. Suker, Schmidt, Priestley Smith, and De Schweinitz have each devised an operation with this end in view, and the following brief account of De Schweinitz' method,* which is a modification of those devised in the first instance by Schmidt and Priestley Smith, and which seems to be the most effective and simple plan, is given in his own words:

“After insertion of a speculum which widely separates the lids, the conjunctiva is divided as close as possible to the corneal margin; each rectus tendon is next exposed and caught upon a hook, precisely as in the operation for strabismus, and is secured with a double-armed black silk suture, which is knotted upon it. The eyeball is now enucleated with the least possible disturbance of the relations between the conjunctiva and the underlying structures, and a small ball of sterilised gauze is inserted into the capsule of Tenon, precisely in the manner in which a Mules' sphere would be so placed in the operation of implantation. Each rectus tendon is now drawn forward to the edge of the cut conjunctiva and securely fastened with the ends of the same suture which had originally secured the tendon, and which have been left long. That is to say, the tendon is brought forward precisely as it would be in the operation of advancement. The wad of sterilised gauze, which has served its purpose of checking entirely the hæmorrhage and keeping for the time being the cavity bulged out as it was

* ‘Therapeutic Gazette,’ April 15th, 1900.

when occupied by the globe, and therefore facilitating the advancement of the tendons, is now removed, and the edges of the conjunctiva and capsule of Tenon are united with interrupted sutures."

The operation necessarily occupies considerably longer time than enucleation by the usual method; but the cosmetic improvement is very satisfactory, though the mobility of the stump is not equal to that obtained after Mules' operation.

Accidents that may follow Enucleation.—It is seldom that any untoward symptoms arise after this operation, but the occasional complications are serious.

a. Orbital Cellulitis.—If symptoms of orbital cellulitis come on, warmth should be applied to the wound by frequent fomentations. If the opening in the conjunctiva has been closed by a suture, it should be at once removed. It is good practice in such a case to make a free incision through the wound in the conjunctiva into the cellular tissue of the orbit, so as to give free vent to all inflammatory exudations as they are effused. By thus encouraging suppuration and favouring the exit of the pus, the urgent symptoms will probably be at once relieved. The bowels should be freely acted on by a purgative, and the patient should be kept very quiet in a darkened room (*see also* "Orbital Cellulitis").

b. Meningitis.—On a few occasions meningitis has set in, usually after enucleation for suppurative panophthalmitis. Nettleship* has collected thirty-four such cases, and Devereux Marshall† has added five more, and of these thirty-nine cases thirty-four proved fatal. It is probable, as Marshall points out, that in some of these the meningitis existed before the operation (*see also* "Panophthalmitis," page 325).

c. Hæmorrhage.—Another rare accident is severe hæmorrhage. We have seen one case of most troublesome hæmorrhage follow enucleation in a hæmophilic subject, and another in which enucleation was followed by slow leakage into the orbital tissues, so that on the second day after operation the conjunctiva and Tenon's capsule were bulged out between the lids by an enormous hæmatoma. A free opening was made and the clots turned out, external pressure applied, and the case subsequently did very well.

It is well to sound a note of warning as regards the performance of enucleation. The mere removal of the eye is a simple matter, and thus it has come about that in very many cases the operation is hurried and carelessly done. The future of the socket, its adaptability for a suitable artificial eye, and the slightly mobility of the latter depend very much upon the way the various steps of the operation are carried out. The cornea should be carefully circumcised, and the various tendons cut upon the hook as closely to the globe as possible, so as to minimise the interference with their insertions into Tenon's capsule.

* 'Trans. Ophth. Soc. U. K.,' vol. vi, p. 445.

† 'Ophth. Hosp. Rep.,' vol. xiv, pt. ii, p. 312.

OPERATIONS THAT MAY BE SUBSTITUTED FOR ENUCLEATION.

EVISCERATION was first introduced by Noyes in 1874. The operation consists in removing the contents of the globe, leaving behind the sclerotic with its attached muscles. The cornea is first abscised by sweeping a knife round the corneo-scleral margin, after which the contents of the globe are removed by a scoop, great care being taken to completely detach all portions of the uveal tract. The interior is then carefully dried, all bleeding arrested, and the corneo-scleral wound closed by a few sutures. A movable stump is thus provided for an artificial eye with good cosmetic effect, but the sclerotic walls fall in from want of support; and a greatly improved modification by Mules has now taken the place of evisceration.



FIG. 146. — Mules' evisceration scoop. 312.

MULES' OPERATION.—This consists essentially of evisceration with the insertion of a glass or silver globe, known technically as an artificial vitreous, into the cavity of the sclerotic. The cornea is removed by an oval incision trespassing slightly on the sclerotic above and below, but elsewhere following the curve of the corneal margin; or, instead, a circular incision round the cornea is made, and the wound afterwards slightly enlarged in the vertical direction. The contents of the globe are thoroughly evacuated with Mules' scoop (Fig. 146), and after careful drying, the artificial vitreous is introduced by an instrument devised by Mules for the purpose (Fig. 147), and the sclerotic wound and cut edges of the conjunctiva sutured over it with fine silk, silkworm gut, or horsehair. The size of the glass globe, which most surgeons prefer to silver, is very important, as it must fit easily and comfortably, so that there is no traction on the sutures. Many sizes are made, so as to suit individual cases. Considerable pain and reactionary swelling follow this operation as a rule, and, owing to the latter, convalescence is a good deal more protracted than is the case after enucleation. The swelling can, however, be somewhat checked by the application of iced compresses, and it generally begins to subside after a few days. For further remarks on this operation *see* page

ENUCLEATION WITH THE INSERTION OF A GLASS OR SILVER GLOBE INTO TENON'S CAPSULE—Adams Frost's Operation.—After enucleation has been performed in the usual way, a glass globe identical with that used in Mules' operation is introduced into Tenon's capsule, which with the conjunctiva is sutured over it. To obtain a good result, the enucleation must be carefully performed, with the least disturbance

of the conjunctiva in circumcising the cornea, and of Tenon's capsule in dividing the muscles and optic nerve. The artificial globe should fit easily and be considerably smaller than the eye removed, and the sutures enclosing it should be inserted in two rows, as recommended by Lang, who has had more experience of this operation than any one else. Lang first closes Tenon's capsule over the globe by three or four deep buried sutures, and then draws together the conjunctival edges by a purse-string suture of fine silk. It is unusual for more reactionary swelling to occur after this operation than after enucleation, and the globe gives rise to no pain. The cosmetic result, though an improvement upon enucleation, is not, however, so good as that obtained by Mules' operation. For further remarks *see* page 312.

The following three operations are obsolete and to be condemned, and are only mentioned on account of the past interest that attaches to them.

Abscission.—This consists in removal of the cornea and uniting the cut edges of the wound by sutures, the contents of the globe being left enclosed. The globe shrinks to a flattened stump, which is apt to become painful and set up sympathetic inflammation in the other eye.

The division of the ciliary and optic nerves (**Optico-ciliary Neurotomy**), or their division with resection of a portion of the optic nerve (**Optico-ciliary Neurectomy**), has been frequently practised instead of enucleation in cases of sympathetic ophthalmitis and to relieve pain in blind glaucomatous eyes. Both operations are apt to be followed by hæmorrhage into the orbit and protrusion of the globe. Pain is relieved by these operations for a time, but in many cases it has returned, probably from reunion of the cut ends of the nerves. In a few instances in which the operation has been performed for the relief of pain, sympathetic inflammation has followed in the other eye, although the operated eye was not previously in a condition liable to initiate sympathetic ophthalmitis.

Comparison between Enucleation and its Substitutes.—For practical purposes, then, the surgeon has to decide between simple enucleation, enucleation with the insertion of a glass globe into Tenon's capsule, and Mules' operation.

Simple enucleation is suitable for all cases; it is the simplest, safest, and speediest operation; it is followed by the quickest convalescence, and it can never fail as the other two may do from escape of the enclosed glass globe.

From a cosmetic point of view, both Adams Frost's and Mules'

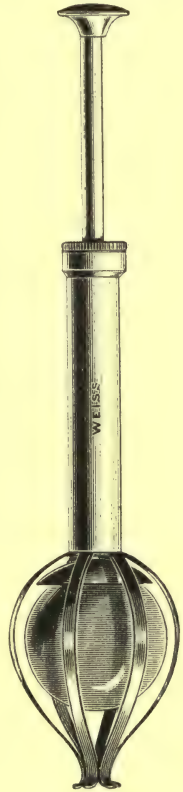


FIG. 147.—Mules' artificial vitreous introducer.

operation are considerably superior to enucleation; the sinking in of the socket is avoided, and the artificial eye rides with much greater mobility on the stump, so that its imposture is often difficult to detect.

Mules' operation labours at present under the serious imputation that it has occasionally been the cause of sympathetic ophthalmitis in the other eye. Could such an accusation be proved, it would be sufficient to condemn the operation for ever; but it has never been so proved. A small percentage of cases of sympathetic inflammation have certainly occurred after this operation, but in the five instances collected by the committee of inquiry instituted by the Ophthalmological Society of the United Kingdom,* the injury that led to the operation was one liable to induce sympathetic ophthalmitis in the other eye; and moreover it followed the operation at a period so short as to render it improbable that the operation could have been a causal factor. On the other hand, one or two cases of sympathetic inflammation have also occurred after enucleation; but having regard to the many thousands of enucleations performed and the extreme rarity of such an accident, it must be confessed that the number of instances in which it has followed the quite recently devised operation of Mules appears somewhat formidable.

The present state of the case appears to be that although Mules' operation cannot definitely be stated to have ever been the cause of sympathetic inflammation, it nevertheless seems to offer less protection from this misfortune than does enucleation; and therefore the latter must be considered to be the preferable measure when an eye has been injured in a manner liable to produce sympathetic ophthalmitis in the other.

The further drawbacks of Mules' operation as compared with enucleation are the pain and reaction, which are often very severe for the first few days after operation, together with its occasional failure either from inability to retain the glass globe or from sloughing of the sclerotic. The first-named objection renders the operation unsuitable for those cases in which a little extra shock is undesirable, such as the old or feeble, or those afflicted with severe constitutional disease; whilst the last-named objections are simply possibilities of failure which the surgeon will be wise to present to the patient before operating. Obviously too, Mules' operation is unsuitable for cases of intra-ocular growth, nor can it be performed when the globe is shrunken from disease or injury of long standing.

To sum the matter up, the somewhat restricted class of cases most suitable for Mules' operation appears to be eyes affected with anterior staphyloma and blind glaucomatous eyes, provided that they are not seriously inflamed and do not contain bone. In suppurative panophthalmitis enucleation has been condemned by some writers as more dangerous than evisceration, but in our opinion it presents no more risk than preserving the sclerotic wall, and enucleation has the advantage of giving immediate relief to the severe pain, which the other does not (*see also* "Panophthalmitis," page 325).

As regards the insertion of a glass globe into Tenon's capsule after enucleation, it has already been pointed out that this method presents

* 'Trans. Ophth. Soc. U. K.,' vol. xviii, 1898, p. 247.

cosmetic advantages over enucleation which are, however, not so great as those obtained by Mules' operation. It possesses this advantage over Mules' method, that it can be performed in every case suitable for enucleation, and it gives rise to little or no pain or reactionary swelling. This operation has not, however, received at present the same favour as that of Mules, chiefly because most surgeons have found a greater difficulty in obtaining a satisfactory union over the globe, and a good many failures have thus occurred; and also because the globe sometimes becomes displaced from its central position into the cone of muscles. The question of sympathetic ophthalmitis occurring as a result of this operation has also been raised, and, like Mules' operation, this point must be considered at present as *sub judice*; but there certainly seems to be less reason to fear danger from this quarter than when the globe is enclosed in the sclerotic. The operation needs to be very carefully performed, and the sutures accurately adjusted, as given in the description; and if attention is given to these points the number of failures will be found to be small—no more than those resulting from Mules' operation.

ARTIFICIAL EYES.

The usual form of artificial eye, or "**Prosthesis**," is a hollow glass shell originally fashioned so as to fit the convexity of an atrophic globe. The practice of ordering an artificial eye to be worn over a shrunken stump has long been discarded, but until recently the pattern of the prosthesis remained unchanged (Fig. 148 A), though unadapted to the socket following enucleation on account of its extreme curve, which permits the edge alone of the prosthesis to rest upon the conjunctiva. Snellen has recently introduced a new pattern (Fig. 148 B), made with a

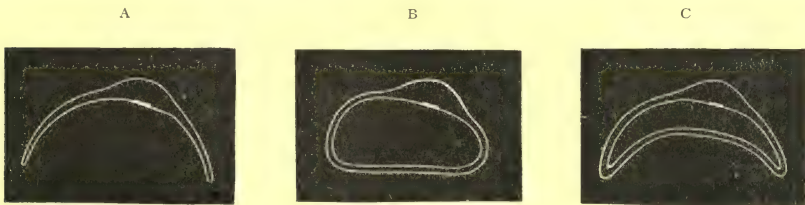


FIG. 148.—Types of prosthesis.

(A) Old pattern, which is still the best after Mules' operation. (B) Snellen's pattern for the socket after enucleation. (C) The same rather hollowed out for wearing after Frost's operation.

flat base and rounded edges, which rests easily upon the conjunctival surface and does away with any scratching or wounding of the conjunctiva, and further, certainly increases the mobility of the eye. Another pattern, slightly more hollowed, can be employed after Adams Frost's operation, whilst the old pattern is still suitable for wearing after Mules' operation.

In an ordinary case from six weeks to two months after enucleation

is the *earliest advisable* time for commencing the use of a glass eye. In every case cicatrisation must be completed, and all swelling and discharge have subsided before an artificial eye is introduced within the orbit.

One of the most frequent inconveniences produced by wearing an artificial eye too soon is a chronic conjunctivitis with a mucopurulent discharge, which is often very troublesome to arrest. Another and a more serious annoyance is an inflammation of the conjunctiva and submucous tissue along the line on which the edge of the artificial eye rests, sometimes going on to ulceration. As the result of this, cicatrices are often formed, which render the adjustment of another eye very difficult, and sometimes impossible. Plastic operations for the relief of contracted socket have been frequently attempted; but they are difficult and usually unsatisfactory. Cicatricial bands may be divided, and an endeavour made to form a fresh bed for an artificial eye by transplanting a graft, either after Thiersch's method, or by turning in a flap from the temple, or transferring a piece of skin, including its whole thickness, from the inner side of the arm or thigh.

Occasionally the continued use of an ill-fitting or rough artificial eye causes an ectropion of the lower eyelid. This is an unfortunate complication which, once initiated, tends to get worse, and, if severe, it will, owing to the resulting obliteration of the sulcus of the lower lid, entirely prevent the wearing of an artificial eye. For its relief the operation of "tarsorrhaphy," or one of the other procedures recommended in the article dealing with ectropion, must be employed.

When a lost eye has been removed on account of the sound one suffering from sympathetic ophthalmitis, an artificial eye should not be allowed until all the sympathetic symptoms have been arrested, and the eye has remained quiet for at least six months.

An artificial eye should be of such a size that the lids can close completely and easily over it, as in sleep, without any squeezing effort on the part of the patient.

It is far better that the glass eye should be rather too small than too large—an artificial eye which is too large leads to many troubles. If the artificial eye is rather small, the patient should be advised to wear spectacles with plane plate glass in front of the seeing eye, and with a convex lens of from 3 to 6 D in front of the artificial eye, so that it may appear to the on-looker as slightly larger than it really is.

An artificial eye should never be ordered for an infant or young child under five years of age, as the necessary daily removal and replacement of it is a source of constant annoyance. As a rule, it is better to wait until the child is nine or ten years of age.

The following excellent rules are given to the patients at the Royal London Ophthalmic Hospital who have had the misfortune to lose an eye:

Instructions for Persons wearing an Artificial Eye.—It should be taken out every night, and replaced in the morning.

To take the Eye out.—The lower eyelid must be drawn downwards with the middle finger of the left hand; and then, with the right hand, the end of a small bodkin must be put beneath the lower

edge of the artificial eye, which must be raised gently forwards over the lower eyelid, when it will readily drop out. At this time care must be taken that the eye does not fall on the ground or other hard place, as it is very brittle, and may easily be broken by a fall.

To put the Eye in.—Place the left hand flat upon the forehead with the fingers downwards, and with the two middle fingers raise the upper eyelid towards the eyebrow; then, with the right hand push the upper edge of the artificial eye beneath the upper eyelid, which may now be allowed to drop upon the eye. The eye must then be supported with the middle fingers of the left hand, whilst the lower eyelid is raised over its lower edge with the right hand.

After it has been worn daily for about six months, the polished surface of the artificial eye becomes rough; when this happens it should be replaced by a new one. Unless this is done, uneasiness and inflammation may result.

CHAPTER XX.

DISEASES OF THE CHOROID.

ANATOMY.—The choroid forms the posterior two-thirds of the uveal tract. It commences anteriorly at the ora serrata, or anterior termination of the retina proper, and thence, gradually increasing in thickness, it forms a deeply pigmented vascular tunic, which is interposed between the retina and sclerotic, except at the site of the lamina cribrosa, where a slight deficiency exists to allow of the passage of the optic nerve into the globe. Externally it is separated from the sclerotic by the *lamina fusca* or *lamina suprachoroidea*, which is a stratum of loose areolar tissue forming the perichoroidal lymph space (*see also* page 234), and which also serves to transmit the ciliary nerves and the long ciliary arteries as they pass to the ciliary body.

The main portion of the choroid is made up of a densely pigmented and exceedingly vascular stroma of connective tissue, which is surmounted internally by a delicate structureless membrane known as the *lamina vitrea* or *membrane of Bruch*. The latter lies in close contact with the hexagonal pigment-cells of the retina, which remain adherent to it when the retina from some cause becomes detached.

The important vascular system of the choroid consists of an internal layer of fine capillaries, derived from the short ciliary arteries, which forms a dense network beneath the lamina vitrea, and is called the *chorio-capillaris*. External to this layer is a series of larger interlacing vessels, mostly composed of veins, which permeate the main substances of the choroid, sometimes termed the *tunica vasculosa*, and which progressively increase in size from within outwards, so that the largest lie in the most external layer adjacent to the lamina suprachoroidea. These vessels, when viewed by the ophthalmoscope, are characteristically flat and ribbon-like, and form a network of straight interlacing branches, which gives them an appearance quite different to that of the superjacent retinal vessels (*see also* page 43). They collect the blood into four or five main trunks, called the *venae vorticosæ*, which pass out of the sclerotic near the equator of the globe, to empty into the ophthalmic vein.

The pigment of the choroid is most dense in its external layers, and

gradually diminishes towards the retina, so that the chorio-capillaris and lamina vitrea are entirely devoid of it.

Unlike the ciliary body, the choroid is not richly supplied with nerves, and inflammation of its structure is unattended with pain.

CONGENITAL ABNORMALITIES.

CONGENITAL ABSENCE OF THE CHOROID.—This must be exceedingly rare. The only case that has come under our notice was one exhibited by Tatham Thompson.* It was present in a lad aged eighteen years, who from early infancy had to "peer round" at objects as though he only saw them when straight in front of him. There was marked night-blindness, and both visual fields were limited to a very small area round the fixation point. With the ophthalmoscope the fundi presented the appearances of dazzling white sclerotic except at the macula itself, where there was a small area of red reflex, which stood out conspicuously against the surrounding white background. The retinal vessels could be seen coursing over the fundus, but the only signs of choroidal circulation were a few small and isolated vessels, possibly the ciliary vessels. The central vision was fair for V \bar{c} — 3 D Sph. = $\frac{6}{9}$ with either eye.

COLOBOMA OF THE CHOROID consists in an absence of the choroid along a line corresponding to the fœtal cleft, which runs from before



FIG. 149.—Coloboma of the choroid. The retina is present in this case, and the retinal vessels are seen to be traversing the coloboma. On the right is a triangular area fringed with pigment, over which the choroid is only defective.

backwards in the mid-line of the floor of the fundus from the optic nerve entrance to the iris. The appearance is that of a sharply defined white patch in this situation, its edges bordered with pigment, and of a variable size corresponding to the area over which the choroid is deficient. The coloboma may thus be limited to a small crescentic patch lying just

* 'Trans. Ophth. Soc. U. K.,' 1899, vol. xix, p. 140.

below the disc (*Fuch's coloboma*), resembling a myopic crescent in everything but its position, and this is the most frequent variety; or in extreme cases it may stretch throughout the antero-posterior length of the choroid, and be joined posteriorly by a coloboma of the optic nerve-sheath, or anteriorly blend with a coloboma of the iris and ciliary body. The retina is generally deficient over the colobomatous area, as may be evidenced by the absence of retinal vessels coursing over the patch and the presence of a corresponding absolute scotoma in the visual field; but there are exceptions to this rule. Collins and Lang* regard the coloboma as due to abnormal adhesion between the primitive retina and the mesoblast, a theory which will account for the presence of the retina in some cases and its absence in others; the retina being present if such adhesion follows closure of the foetal cleft, but absent if adhesion precedes it. The diagnosis of coloboma from a patch of choroidal atrophy due to disease is made by its position, its sharply defined margins, its linear shape, the presence of coloboma of the iris, etc., and the healthy condition of the fundus immediately bordering the patch and elsewhere. A general lowering of visual acuity is common in eyes affected with choroidal coloboma, as they are frequently ill-developed in other respects.

MACULAR COLOBOMA.—This is a name given to a congenital white depression placed round the macular region, generally of considerable size, sharply circumscribed, roughly circular in shape, with the well-

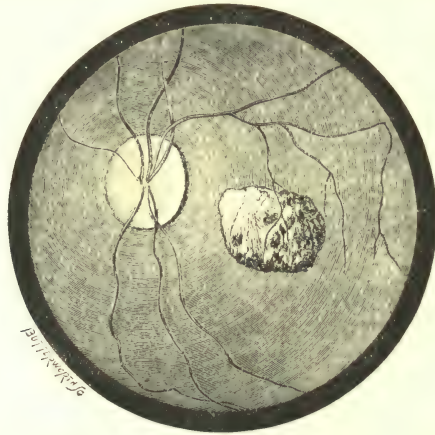


FIG. 150.—Macular coloboma. It has the appearance of a swelling, but is really a depression. A retinal artery can be seen crossing the coloboma, showing that the retina is present. Central vision was much diminished in this case.

defined edge bordered with pigment so characteristic of coloboma of the choroid. In shape it is generally oval with the long diameter placed horizontally, and in the cases which we have seen it is rather longer than the optic papilla (see Fig. 150). The retina generally seems to be present in these cases, so that the sight, though always defective, is not abolished over the affected area. The defect is termed a coloboma for

* Norris and Oliver, 'System of Diseases of the Eye,' vol. i, p. 444.

want of a better name; but its exact pathology is not understood. Silcock* has recorded a case in which a persistent hyaloid artery entered the globe through one of these patches.

ALBINISM.—In the most marked forms there is complete absence of pigment so that the choroidal circulation is completely exposed, and its vessels are seen coursing and interlacing over the white background of the sclerotic. The fundus reflex is correspondingly lightened in colour, and is reflected through the pupil, so that the patient appears to have pink eyes. It must be understood that the structure of the choroid is unaltered in albinos, and that the pigment-cells are present although they contain no pigment. Albinos have necessarily very defective sight, especially in bright lights, when they usually exhibit considerable photophobia. Strabismus is common and nystagmus is always present, as in all varieties of congenitally defective vision. The only relief we can afford these patients is to correct refractive errors and to order neutral-tinted protectors, to shield the eyes from glare.

CHOROIDITIS.

Inflammation of the choroid may be either **exudative** or **suppurative**. Exudative inflammation may be either (1) *diffuse or disseminated*, or (2) *circumscribed*. The diffuse variety may spread forwards and involve the ciliary body and iris (choroido-iritis), or it may commence in the latter and secondarily involve the choroid (irido-choroiditis). Choroiditis produces no subjective symptoms beyond the lowering of sight due to secondary affection of the retina and vitreous, which frequently occur, and if the inflammation is confined to the anterior portions of the choroid, the patient may be quite unaware of any trouble in his eyes. Permanent atrophic changes are very apt to follow the exudations. When a portion of the choroid is completely wasted, the sclerotic is exposed to view, and the patch therefore appears densely white; whereas if some choroidal tissue still remains, the atrophic area is buff-coloured, or of a lighter shade than the healthy choroid. Proliferation of the uveal pigment is also a frequent accompaniment of the exudations, and remains permanently as irregular black blotches, which fringe or are scattered over the atrophic areas.

EXUDATIVE CHOROIDITIS.

I. DIFFUSE OR DISSEMINATED CHOROIDITIS.—This occurs in two forms, the *syphilitic* and the *simple*. It is most frequently the result of syphilis, but it may also occur in patients who are free from all specific taint, and from causes too indefinite or remote to be accurately traced. It is characterised by disseminated buff-coloured exudations on the surface and into the tissue of the choroid. These effusions are generally circumscribed, and between them portions of unclouded choroid are seen through the retina.

* 'Trans. Ophth. Soc. U. K.,' vol. xx, p. 188.

Frequently the retina becomes secondarily affected, and choroidoretinitis is established. Without, however, being involved in the inflammatory action, portions of the retina may be so pressed on by the exuded lymph as to cause a temporary suspension of its functions, and, if long continued, atrophy of its structure. A general turbidity of the vitreous with filmy opacities is frequently associated with this form of choroiditis, and especially if it has a syphilitic origin.

General Symptoms.—A gradual failure of sight; surrounding objects appear dark and confused; occasionally the field of vision is contracted, or parts of it are destroyed, so that in certain directions the patient sees only a portion of the object he looks at. The pupil is slightly dilated and sluggish. These symptoms, however, are common to other deep-seated affections of the eye, and it is only by the aid of

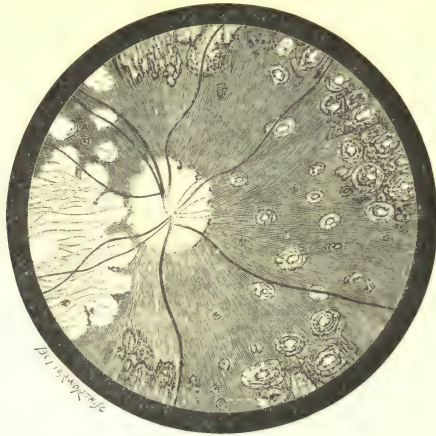


FIG. 151.—Disseminated choroiditis from a case of congenital syphilis. The greater part of the fundus is seen to be dotted over with little punched-out patches, each of which exhibits varied degrees of atrophy, usually most marked in the centre of the patch. On the left is seen a large irregular plaque of atrophied choroid, across which many deep choroidal veins still run. The optic disc exhibits the atrophy that follows inflammation (post-neuritic atrophy), and the retinal vessels are much attenuated.

the ophthalmoscope that the exact locality of the disease can be determined. When thus examined, the patches of exudation will be seen scattered over the fundus of the eye; those that are recent will be recognised as opaque, yellowish spots, whilst the site of old effusions will be here and there indicated by the glistening white of the sclerotic shining through the atrophied portions of choroid, which are mapped out by aggregations of pigment. When the inflammatory action is confined to the choroid, the retinal vessels may be clearly traced throughout their course, and in places mounting over the effusion which is beneath them; and there are none of the hæmorrhages so characteristic of most forms of retinitis.

If the retina is affected, as very frequently happens when this disease is due to syphilis, a diffused haziness of a part or whole of the fundus, with interruptions in the course of the retinal vessels from inflammatory

effusion, will mask many of the ophthalmoscopic signs already mentioned. When, in addition to the retinitis, there is also a turbidity of the vitreous, it is often impossible to make out the details of the changes which may have taken place, but sufficient information will probably be gained to form a diagnosis of the case.

In the **syphilitic** form the exudation is very circumscribed, and most marked in the periphery of the fundus. The patches often appear in nodules closely resembling those which are so frequently seen in specific iritis, and there is no tendency for the effusions to run together. This exudative choroiditis sometimes occurs as an extension of the iritis, and it is then associated with, or follows closely upon, the secondary eruption of the skin. It is also met with during the tertiary symptoms of syphilis, and is then usually complicated with retinitis. Children with inherited syphilis are subject to this affection, and the eyes are then apt to suffer from a malignant form of myopia.

In the **simple** form the disease rather resembles simple iritis in which the effusion is small in quantity and evenly diffused. The patches on the choroid are less circumscribed, and they have a tendency to coalesce. The disease is more chronic and less amenable to active treatment.

Treatment.—If the disease is due to *syphilis*, the treatment which is recommended for retinitis syphilitica, page 343, should be adopted. When the disseminated choroiditis follows or is associated with the secondary skin eruption, the iodide of potassium with mercurial bath every night, or with pil. Plummer. gr. v every night, may be ordered; or if the patient has not yet been under the influence of mercury, the unguent. hydrarg. may be rubbed into the axilla or inner side of the thigh every night until the gums are slightly affected. If, however, the disease does not occur until the tertiary period of syphilis, reliance must be chiefly placed in iodide of potassium, which should be employed in gradually increasing doses, according to the effect produced.

In the simple disseminated choroiditis, small doses of iodide and bromide of potassium, or of the liq. hydrarg. perchlorid. should be prescribed and continued for some weeks, and at the same time a slight mercurial counter-irritation may be kept up by rubbing a little of the Unguent. Hydrarg. Iodidi Rubri (F. 64) into the temple every night. If, however, the patient is very feeble and anæmic, the mercurial medicines should not be given internally, but full doses of quinine or quinine and iron should be ordered, and the Unguent. Hydrarg. c. Belladonna (F. 63) rubbed into the brow and temple every night.

2. CIRCUMSCRIBED EXUDATIVE CHOROIDITIS—SENILE CHOROIDITIS.—In old people a chronic symmetrical choroiditis limited to the region about the macula, is fairly frequent. It may assume one of two forms, the **areolar** or the **guttate**. In areolar choroiditis a large irregularly shaped patch of choroidal atrophy occupies the neighbourhood of the macula. It is generally seamed and bordered with pigment, and in places is densely white, whilst elsewhere buff-coloured patches and streaks mark out a less complete destruction of the tissue. In the guttate form the changes are of a much less extensive character,

and the choroid is dotted over with minute black or whitish-yellow specks, giving the macula the appearance of having been dusted over with a mixture of pepper and salt. In both forms the discs are pale, but the peripheral portions of the fundi appear quite normal.

The exact causation of the disease is obscure, but the asthenic type of the inflammation, coupled with the fact that the patients are always elderly and usually broken down in health, points to its being a process of senile degeneration. The retina is always involved, and central vision is consequently always much lowered; but as the disease progresses very slowly useful sight may be retained for a long time. It is of especial importance in cases of early senile cataract to carefully examine the macular region for senile choroiditis, as its presence will materially affect the result of subsequent operation, and when the lens is opaque, subjective examination of the power of light projection may not reveal any disease. The possibility of its presence should also make the surgeon guarded in his prognosis as to the result of extraction when he sees the patient for the first time with both lenses opaque.

Treatment.—The eyes should be protected from strong lights, and all attempts at close work forbidden. We should further attend to the patient's general health, and by these means may hope in some cases to check the progress of the disease, though we cannot restore the sight to its former acuity.

3. CIRCUMSCRIBED CHOROIDITIS WITH KERATITIS PUNCTATA.—A rare form of choroiditis consists in a localised patch of acute choroidal inflammation, situated in the immediate neighbourhood of the disc and accompanied by the presence of dust-like opacities on the posterior surface of the cornea. The latter are similar to those that accompany serous iritis and the choroiditis that may arise secondarily to this disease; but in the cases under consideration the aqueous is quite clear, the iris perfectly healthy and the pupil active. The keratitis punctata usually disappears within a few days of the onset of the disease, but the choroiditis runs a more tedious course and terminates in a patch of choroidal atrophy. The retina is involved, so that the defect is marked by a scotoma in the visual field. Exudation also occurs into the vitreous over the inflamed patch, and partial liquefaction with permanent opacities may follow. The origin of the disease is doubtful. Hill Griffith,* who was the first to draw attention to this form of choroiditis, has found tuberculosis or a tubercular family history in many cases, but has never seen it associated with syphilis. In a case recently under our care the patient was excessively gouty. The cause of the keratitis punctata must be due to the affection spreading through the vitreous to the ciliary body and causing serous exudation from the ciliary glands, strictly circumscribed as is the choroidal inflammation, and insufficient in extent to cause any other external evidence of inflammation.

The **treatment** consists in rest for the eyes by protection with tinted glasses, a little weak atropine as long as the keratitis punctata is present, and medicinal treatment according to any indication of the cause. If the latter is obscure, a light course of mercurial inunction combined with

* 'Trans. Ophth. Soc. U. K.,' vol. vii, p. 137.

counter irritation in the shape of an occasional blister to the temple, and internal treatment with strychnine and iodide of potassium may be useful.

Sclero-choroiditis Posterior — *Posterior Staphyloma*. — This condition accompanies the severe forms of myopia, and is discussed in the article devoted to that subject.

SUPPURATIVE CHOROIDITIS—PANOPHTHALMITIS.

This is an acute suppurative inflammation commencing in the choroid and rapidly spreading so as to involve all the tissues of the eye. It is most frequently induced by an injury, such as a penetrating wound, or the lodgment within the globe of a foreign body, or an abrasion or burn of the cornea. It may also follow cataract or other severe operations on the eye, and occasionally it will come on in patients suffering from pyæmia, or exhausted by fever or by long-continued bad living. As an example of pyæmic infection, we have recently seen a child in whom the panophthalmitis followed in a few days upon a tonsillar abscess.

Symptoms.—Intense injection of the globe with chemosis of the conjunctiva, and œdematous swelling and redness of the lids.

The *aqueous* first becomes serous, then turbid from lymph and pus; and these, sinking to the bottom of the anterior chamber, constitute the state known as hypopyon.

The *iris* loses its striation and brilliancy from inflammatory exudations on its surface and into its substance, and the pupil becomes blocked or occluded with the exudates.

The *cornea* becomes dull and steamy, and pus may be infiltrated between its laminae, a condition recognised as onyx or corneal abscess; or an irregular sloughing ulcer may appear on its surface.

The *ciliary processes* become infiltrated with lymph and pus, and matted to each other.

The *vitreous humour* grows turbid, and lymph and pus are effused into it, and if the pupil be sufficiently clear the purulent infiltration of the vitreous may be recognised by a characteristic yellow reflex.

Similar exudations also take place on the surface of the retina, and in some cases between the retina and choroid and between the choroid and sclerotic, all of which tissues may be covered with morbid deposits, and even separated from each other by them.

The *intra-ocular tension* is raised so that the eye feels very hard, and is acutely tender to even light palpation.

Movements of the eye speedily become limited or even abolished by the spreading of the inflammation to Tenon's capsule and the subjacent orbital tissues, which become matted to the globe.

The *pain* of ophthalmitis is always very severe, and sometimes agonising. It is usually sufficient to cause severe constitutional depression, so that the patient is often quite broken down in health after a few days.

The prognosis of panophthalmitis is very unfavourable. Occasionally, under judicious treatment combined with other favourable circumstances, the inflammation may subside, and a useful, although a somewhat

damaged, eye be preserved. Generally, however, the activity of the disease continues unabated, and does not expend itself until all the tissues of the eye are involved in one general suppuration. The cornea then gives way, or the pus makes an exit for itself through the sclerotic between the insertions of two of the recti tendons. The escape of the pus is then followed by shrinking of the globe (phthisis bulbi).

An important form of acute choroiditis may be here mentioned. It appears to be limited to children, is sometimes bilateral, and the exudations consist of plastic lymph. It remains limited to the uveal tract, and consequently does not tend to cause rupture of the globe. The origin is sometimes obscure, but some cases have been definitely proved to be due to an extension of a meningitis which has originated from middle-ear disease. The subsidence of the inflammation is followed by lowering of the intra-ocular tension, the result of the shrinking of the vitreous and consequent detachment of the retina. Objectively, a yellow reflex from the exudation is seen to occupy the pupil, the cornea is somewhat hazy, and the iris is completely bound down by adhesions and pushed forwards centrally, whilst the periphery is retracted. The child does not complain, and is brought by the mother, who notices the yellow reflex in the pupil. This condition is clinically known as "**pseudo-glioma**" on account of the frequency with which it has been mistaken for the presence of a true gliomatous tumour, and the eye removed on this supposition. The yellow reflex seen through the pupil with the shallowing of the anterior chamber are the misleading signs; but a mistake will not often be made if the following points are borne in mind:

	<i>Pseudo-glioma.</i>	<i>True Glioma.</i>
Reflex . .	Dirty yellow.	Whiter and more lustrous. Often new vessels may be seen.
Iris . . .	Iritic adhesions. Iris pushed forwards centrally, retracted peripherally.	No adhesions. General equal shallowing of the chamber.
Tension .	Generally decreased.	Never decreased; may be heightened.

Treatment.—The eye should be frequently fomented with the *Fotus Belladonnæ* (F. 7) or with the decoction of poppy heads. A solution of atropine, (grs. ii ad aquæ ʒj), should be dropped into the eye twice or three times a day; but it should be discontinued as useless when suppuration has actually set in. The patient should be kept in a darkened room, and all use of the eyes should be prohibited. The bowels should be acted on at the commencement of the attack, and if the patient is restless, sleep should be produced, and the pain relieved by opium. The strength of the patient should be maintained by a liberal strong beef-tea diet, with a moderate allowance of wine or brandy. But if the inflammation goes on, and the cornea becomes ulcerated or infiltrated with pus, or if there is hypopyon, and the anterior chamber is deepened by the increased secretion of the aqueous, tapping the anterior chamber

with a broad needle will sometimes afford very considerable relief and materially benefit the eye (*see also* page 208). Frequently the activity of the disease is sensibly diminished after one such operation. It is not, however, a proceeding which should be undertaken rashly, as, when it fails to do good, it often seems to irritate the eye and increase the urgency of the symptoms.

When the operation gives ease, it may be repeated at intervals of twenty-four or thirty-six hours if the pain and acute symptoms recur; but if after once tapping the anterior chamber the pain in the eye is increased, it should not again be attempted.

If all treatment has failed to arrest the progress of the disease, and suppuration of the globe has actually set in, the eye should be excised. The patient will thus be quickly restored to health, and be spared much suffering. Some surgeons consider that the removal of an acutely suppurating eye is attended by a risk of meningitis. Undoubtedly septic meningitis has occurred in a few cases; but there can be no doubt that in some of them septic infection of the meninges had already occurred at the time of operation. The chief danger lies in allowing any escape of pus into the cellular tissue of the orbit during removal, and this can be obviated by first eviscerating the contents of the globe, and subsequently removing the sclerotic shell. With this precaution the surgeon may enucleate the eye without fear and, in our opinion, with less danger to the patient than if the eye is retained (*see also* page 309).

DEGENERATION OF THE CHOROID.

DEGENERATION OF THE CHOROID WITH SCLEROSIS OF THE CHOROIDAL VESSELS.—A rare condition in which the hexagonal pigment-cells of the retina and the chorio-capillaris atrophy, exposing the deeper layers of the choroid and the choroidal vessels to view. The normal fundus reflex is replaced by one of a brownish hue, over which the interlacing choroidal vessels are seen to course. The latter are pale and marked laterally by white streaks from thickening of their coats, whilst in some places the sclerosis is so advanced that the vessels are converted into white bands, and no blood column can be perceived. The retinal elements also share in the process, so that the optic nerve is pale and the retinal vessels attenuated. The picture is one of degeneration pure and simple, and no signs of inflammatory exudation or proliferation of pigment are visible. The atrophic process may be so extensive that the whole fundus is involved, and vision is then much reduced. Recorded cases have thrown no light on the ætiology of this condition. Treatment is of no avail.

COLLOID DEGENERATION OF THE CHOROID is one of the changes which are apt to take place in eyes which have been lost from either accident or disease. It may occur at any period of life, and may be met with in eyes which have retained their normal shape, as well as in those which have become shrunken. Colloid globules are seen on making a section of the eye as small white bodies scattered singly or grouped in

little masses projecting beyond the surface of the choroid. Examined with the microscope they present a peculiar and characteristic appearance. When fresh they are seen as transparent shining globules which refract the light strongly, and somewhat resemble the bright translucent crystals of white sugar candy. They arise in or just under the lamina vitrea of the choroid, are structureless, but prone to calcify, and appear to be most frequent in eyes that have been subject to repeated attacks of inflammation.

Colloid bodies are sometimes found in perfectly healthy eyes, and then appear as small, whitish, slightly raised spots over which the retinal vessels pass, and which lie scattered discretely or aggregated into small raspberry-like clusters in the neighbourhood of the disc and macula.

DEPOSITS OF BONE ON THE CHOROID are frequently found in eyes that have been long lost. The bony matter is always situated on the internal surface of the choroid, between it and the retina, which is always detached and usually completely so. In some cases a mere ossific film



FIG. 152.—Two examples of bony degeneration of the choroid. In A the formation of bone is exceptionally large, and almost completely fills the globe. B represents the more usual appearance, in which the bony deposit is chiefly congregated about the optic nerve. In B the retina is completely detached, but the little canal through which the central artery still passes is well shown.

is found lying on the choroid, whilst in others there is a thick bony cup, sufficient in size to occupy nearly the entire stump (Fig. 152 (A)).

The deposit of bone commonly commences in the immediate neighbourhood of the papilla, and is usually perforated by a small canal, through which a band of atrophied retina containing the central artery passes back to the optic nerve (*see* Fig. 152 (B)).

It seems very probable that the formation of these bony plates is due to an inflammatory exudation of lymph on the surface of the choroid, which after a lapse of time becomes organised and converted into fibrous tissue. This afterwards undergoes a further change; osseous granules are deposited within it, and it becomes bone, having all the characters, both anatomical and chemical, which distinguish this tissue in other parts of the body.

Whilst bone is thus being developed in the fundus of the eye, earthy salts, such as the phosphate or carbonate of lime, are frequently at the same time deposited in the lens or its capsule, and between the laminae of the cornea; or, if that has been destroyed, in the cicatricial tissue which has replaced it.

INJURIES OF THE CHOROID.

RUPTURE OF THE CHOROID.—The choroid may be split by a blow which ruptures the sclerotic, or may be lacerated by a penetrating wound (see “Injuries of the Sclerotic”); but the term “ruptured choroid” is exclusively used to denote a rent of the choroid coat unattended by a wound of the sclerotic as well. It is caused by an injury similar to that which produces a rupture of the globe, *viz.* by a severe blow applied directly to the front of the eye. If the cornea gives way under the blow, this injury to the choroid will probably not occur; but if the cornea remains intact, the force of the blow is expended in crushing or compressing the eye, and this compression, if sufficiently severe, will either rupture the globe, or, in less severe cases, will split the choroid. Bearing this method of causation in mind, it is easy to see why rupture of the choroid invariably occurs at or near the posterior pole of the eye, where the globe is less supported than laterally, and where, therefore, the



FIG. 153.—Vertical rupture of the choroid on the outer side of the disc. One of the split areas just borders on the macula. Central vision was much lowered ($\frac{6}{60}$).

effects of the compression would be most severely felt. If, on the other hand, the blow were sufficiently severe to cause rupture of the globe, the crushing effects of such an injury would, as we have seen, be manifested close to the site of its infliction.

After such an accident as this, intra-ocular hæmorrhage will for a time mask the extent of the damage; but when this has cleared up, the rent in the choroid will be seen as a sharply defined jagged streak over which the retinal vessels cross; densely white where the split in the choroid has been complete, and of a pale buff colour where some portion of the choroid, usually at the extremities of the rupture, still remains intact. Two or more of these linear splits may in some cases be observed, and it will be noticed that they all lie in the neighbourhood of the posterior pole of the eye, quite close to and usually on the outer side of the optic disc. In direction they are usually more or less vertical,

and present a slightly concave outline towards the nerve (*see* Fig. 153); but to this rule there are occasional exceptions, and the rupture may be horizontal, as in Fig. 154.

The damage to vision will depend chiefly upon the integrity of the macula. The retina may be severely injured or destroyed over the site of the rupture, but as long as the latter does not involve the macula, good sight may be regained after the primary effusion of blood has become absorbed.

Treatment.—The eye must be kept in a condition of absolute rest. This is best effected by paralysing the accommodation with atropine, which should be employed for both eyes, and by shielding the eyes from strong light by means of neutral-tinted protecting glasses. A few days'

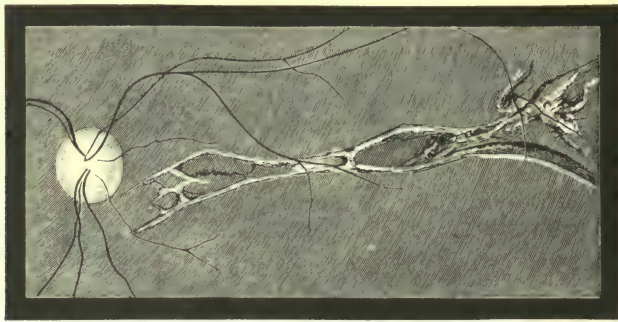


FIG. 154.—This is a very good example of the rarer form of rupture of the choroid, in which the splitting has occurred horizontally to the outer side of the disc.

rest in bed will also promote the absorption of blood, and favour the subsidence of any reactionary inflammation.

DETACHMENT OF THE CHOROID very rarely occurs clinically, except as the result of hæmorrhage between the choroid and the sclerotic (*see* next section), or from a sudden severe loss of vitreous. Blows on the eye may very occasionally produce a detachment; but as a rule the choroid is split by the injury and not separated. In long lost or shrunken eyes the choroid together with the retina is sometimes found completely detached, with a serous exudate occupying the remains of the vitreous chamber. The ophthalmoscopic picture of a detached choroid is, as will be gathered from what has been said, of extreme rarity. The clinical signs would be the presence of a detachment of the retina, through which the choroidal vessels could be distinctly recognised.

HÆMORRHAGE FROM THE CHOROID.—Extensive hæmorrhage from the choroid may break through the retina into the vitreous, or may detach the choroid from the sclerotic. When of small extent and occurring between the choroid and retina, its situation may be recognised by the pushing forwards of the retina at this spot, and by the retinal vessels which are seen to be anterior to it and curved as they pass over the sides

of the swelling. The hæmorrhage itself presents a uniform dark surface, and even in slight cases is usually much larger than most retinal hæmorrhages. Hæmorrhage between the choroid and sclerotic uncomplicated with hæmorrhage in any other part of the eye is most commonly produced by an escape of the lens and a sudden loss of vitreous through a wound in an *unhealthy eye*, thus unexpectedly withdrawing the support which the choroid and retina have derived from these structures, when, in their entirety, they occupied their normal position within the globe.

In a healthy eye the lens and a large amount of vitreous humour may be lost through a wound of its external coats without exerting any very unfavourable influence on the retina or the choroidal vessels; but in an *unsound eye* a similar loss would probably produce hæmorrhage between the choroid and sclerotic. It is this form of hæmorrhage which occasionally occurs after an operation for the removal of a cataractous lens from an unsound eye. Indeed, it is almost certain to happen if there be an increased or glaucomatous tension of the eye at the time of operating. In such cases the hæmorrhage takes place from the posterior surface of the choroid, detaching the choroid sometimes partially but generally completely from the sclerotic, and forming a large blood-clot which pushes in front of it the choroid and retina, and extrudes more or less of the vitreous from the eye.

When hæmorrhage between the choroid and sclerotic is occasioned by blows on the eye, the bleeding is seldom confined to the space between the choroid and retina, but takes place also in other parts of the eye, and blood is often found on the retina, between it and the choroid, and in the vitreous.

The prognosis of choroidal hæmorrhage is always unfavourable. It is only when the bleeding has been slight and limited to a small surface that even a hope can be held out that a certain amount of useful sight will be retained. If in such a case the patient progresses favourably, he will probably recover with some valuable sight, but he will not regain that which was destroyed by the blood-clot: one blind spot in his field of vision will indicate the extent of retina which has been detached, and the loss the eye has sustained. When there is extensive choroidal hæmorrhage, the eye for all visual purposes is lost; no matter whether the blood is effused into the vitreous, or between the retina and choroid or the choroid and sclerotic. A hæmorrhage occurring between the choroid and sclerotic during an intra-ocular operation generally results in the eye having to be removed in a day or two on account of the severe pain and reactionary inflammation.

Treatment.—The eyes should be rested and protected from strong light, otherwise the treatment must be purely symptomatic. There are no special medicines or applications which can be given with a view to favouring absorption of the blood that has been effused.

TUMOURS OF THE CHOROID.

MALIGNANT TUMOURS.—**Carcinoma** is a rare form of choroidal tumour, and is nearly always secondary to disease of the mamma or

lung. Very few cases of primary carcinoma of the choroid have been recorded, and until recently it was gravely doubted if it ever occurred. Most if not all cases of primary intra-ocular carcinomata have arisen in connection with the glandular epithelium lining the ciliary processes, but the pigment epithelium of the choroid may now and then be the starting-point of the disease. The symptoms and treatment are similar to those described in dealing with sarcoma of the choroid (*vide infra*).

Sarcoma is by far the most frequent form of choroidal tumour. It generally occurs as a deeply pigmented growth (*melanotic sarcoma*); but the quantity of pigment is very variable, and is sometimes very scanty (*leuko-sarcoma*). It grows from the connective tissue of the choroid, the slightly pigmented forms probably originating in the anterior layers,

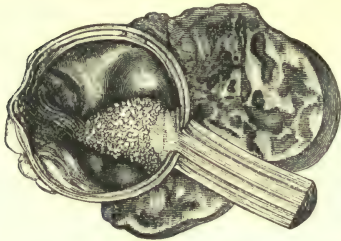


FIG. 155.—Sarcoma of the choroid which originated in a lost eye, and has spread through the sclerotic and nerve, and has invaded the orbital tissue.

where pigment is scanty. The disease rarely if ever occurs in childhood, and is most commonly met with in elderly people or those in the prime of life. It exhibits considerable malignancy, and local recurrences and metastases are frequent even if the eye is excised at an early period of the disease. It is apt to arise in eyes which have been long lost either from injury or disease.

Progress of the Disease.—A small nodule first appears on the choroid, which detaches the portion of retina with which it is in contact, and loosens also that which surrounds it. As it grows it pushes the retina forwards, displaces the vitreous, and presses the lens and iris towards the cornea. At this stage the tension is often increased, and acute glaucomatous symptoms may in some instances supervene. Devereux Marshall* has shown that the cause of the increased tension is not influenced necessarily by the size of the tumour, short of its being so large as to fill the globe, but depends upon closure of the angle of the anterior chamber; and that this actually occurs more frequently in sarcoma of the choroid proper than when the ciliary body is the primary seat of the disease. Frequently the globe loses its normal shape, and dark bulgings will be seen in the ciliary region.

The cornea grows dull, then ulcerates, and through the opening the tumour crops out; or else it makes an exit for itself posteriorly, and bursting through the sclerotic, it extends into the orbit. Having escaped from within the globe, it seems as if it had acquired new vitality, and grows with an increased vigour. If the tumour has burst through the globe anteriorly, its surface after a time ulcerates and bleeds, and it assumes an appearance which has given to it the name of “fungus hæmatodes.” The attacks of hæmorrhage increase in frequency with the advance of the disease until the patient at length sinks, worn out with pain and loss of blood.

Symptoms.—The first symptom which generally draws attention to

* ‘Trans. Ophth. Soc. U. K., vol. xvi, p. 155.

the eye is the loss of sight, which may be either partial or complete, according to the size and situation of the tumour. At the commencement of the disease there is usually no pain as a warning of the approaching evil, but as the tumour grows and distends the globe there is often excessive suffering.

Diagnosis.—The presence of a *circumscribed nodular* detachment of the retina without any apparent cause for detachment, such as injury, high myopia, etc., is very suggestive of intra-ocular tumour, and is pathognomonic if we see new vessels and hæmorrhages at the site of the detachment. The diagnosis is further strengthened if there be increase of tension, which never occurs in detachment from other causes; but in early stages of the disease we rarely have this symptom to guide us, and, as above mentioned, a large tumour may be present without any rise of tension. The diagnosis is often obscure from various causes. Thus the typical nodular protuberance may be replaced by a large flatter detachment of doubtful character, or the fundus may be hidden by vitreous opacities, or the patient first comes under observation with glaucomatous symptoms that mask the presence of a tumour. A close watch must be kept over doubtful cases, which will probably soon clear up the diagnosis.

Treatment.—The eye should be excised as soon as possible, though good sight still remains; and care should be taken to divide the optic nerve as near the apex of the orbit as possible. If the tumour has made its way through the sclerotic into the orbital tissues, a complete exenteration of the orbit must be performed.

TUBERCLE.—**Miliary tubercles** are sometimes deposited in the choroid. They occur most commonly in patients suffering from acute tuberculosis, and with less frequency in the course of tubercular meningitis. They are always a late symptom, frequently not appearing until a few days before death, and they produce no defect of sight; facts that perhaps account for their presence not being more often discovered. With the ophthalmoscope they may be recognised as small, circular, slightly raised and circumscribed spots of a pale rose colour or greyish-white tint, chiefly situated in the neighbourhood of the disc.

A rarer form of tubercular deposit consists in a tumour commencing in the choroid, which sets up a general plastic inflammation of the uveal tract and, detaching the retina, slowly fills the globe with breaking-down tuberculous material, so that the eye is completely destroyed. This variety is associated with chronic tuberculosis of the lungs, joints, or glands, and may be the means of destroying both eyes.

Treatment.—Miliary tubercles are not amenable to treatment. In the second variety of tubercle excision of the affected eye should be performed lest it should prove a focus of dissemination.

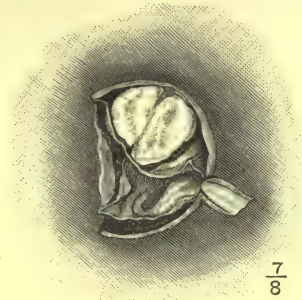


FIG. 156.—Leuko-sarcoma of the choroid.

CHAPTER XXI.

DISEASES OF THE RETINA.

ANATOMY.—The retina is divisible into two parts—(1) an external layer of hexagonal pigment cells only lying in contact with the rest of the retina, and remaining adherent to the choroid when the retina is detached, and (2) an internal nervous layer composed of several strata of complicated cells and fibres. Anteriorly, the nervous elements of the retina cease abruptly at a well-marked serrated line situated just behind the ciliary processes and known as the *ora serrata*. From this point the retina, now merely represented by the hexagonal pigment cells lined internally by a stratum of non-pigmented cells, is continued forwards as the "*pars ciliaris retinae*," to line the posterior or internal surface of the ciliary body and iris. The retina, separated from the vitreous by the hyaloid membrane, is everywhere easily detached from its bed except at the optic papilla, from which it may be said to spring, and at the *ora serrata*, where it is closely adherent to the subjacent choroid.

Only a few features of the complicated structure of the retina need be mentioned here. The optic fibres, after radiating from the disc, spread out over the internal aspect of the retina, whence a series of strata of specialised cells conduct the axis cylinders to their ultimate terminals, the rods and cones, which are situated next to the pigment layer. A little to the outer side of the optic disc is situated the "*macula lutea*" with its central depression, the "*fovea centralis*." At this spot the retina is exceedingly thin, and consists chiefly of cones very thickly placed together with a few rods, and exhibits a specially bright reflex from the subjacent choroid.

The blood-vessels of the retina run in the internal layers, and do not penetrate so far as the layer of rods and cones, and consequently there are no blood-vessels in the fovea itself. The arteries are derived from the *arteria centralis retinae*, which enters the globe with the nerve and branches dichotomously throughout the retina. No anastomoses take place between the arterial twigs, an important fact to remember, as it

greatly influences the prognosis in cases of arterial embolism or hæmorrhage. Occasionally, however, a few twigs from one of the ciliary arteries supply a portion of the retina near the disc (*cilio-retinal artery*), and may be sufficient to maintain the circulation over a small area when the main arterial supply is cut off. The veins empty into trunks corresponding to the main arterial divisions, and thence pass out of the globe as the *vena centralis retinæ*, to join the ophthalmic vein and cavernous sinus.

CONGENITAL ABNORMALITIES.

OPAQUE NERVE-FIBRES.—Sometimes a certain number of the optic nerve-fibres retain their medullary sheaths, and they then appear as white glistening streaks radiating from the disc in a fan-shaped manner. They have a peculiar feathery appearance (Fig. 157) which is quite characteristic, and serves to distinguish the condition from a



FIG. 157.—Opaque nerve-fibres.

patch of atrophied choroid, for which they are often mistaken by the inexperienced. A further guide is the retinal vessels, which often pass *under* as well as over them. The retina is anæsthetic over the site of these fibres, so that, if large enough, a definite scotoma can be mapped out with the perimeter.

CRICK-DOTS.—Marcus Gunn* was the first to describe a curious condition which is not infrequently seen, and which consists of a series of highly refractile dots spangled round the disc and placed anterior to the retinal vessels. They are only to be seen with low illumination by the direct method. They have no pathological significance, but are sometimes hereditary, or found in several members of the same family.

* 'Ophthalmic Review,' 1889.

Anatomical peculiarities in the course and distribution of the retinal vessels are very frequent, but they are unimportant, and need no special description. Cilio-retinal vessels have already been mentioned (*see* "Anatomy").

PATHOLOGICAL CHANGES IN THE RETINAL CIRCULATION.—The presence of a **venous pulse** is frequent and purely physiological; **arterial pulsation**, on the other hand, is always pathological, and may be caused either by abnormal increase of the intra-ocular pressure, as in glaucoma, or by diminished pressure in the artery itself, as in aortic regurgitation.

Arterio-sclerosis occurs in chronic interstitial nephritis, in old subjects, and in cases of long-standing syphilis. It is evidenced by tortuosity of the vessels, increase in the central light reflex, which is



FIG. 158.—Subhyaloid hæmorrhage. (From a case of Mr. Percy Flemming's.) The curious sharp limitation of the hæmorrhages with their bowl-like contour is well shown. Their position altogether in front of the retinal vessels should be noted.

very bright, though narrowed, and general loss of translucency, making a picture to which Gunn has aptly applied the name "**silver wire.**"

Inflammatory changes in both arteries and veins are marked by the presence of cloudy exudation about the vessels, or by white streaks along the vessel-walls partially hiding the blood-column, which appears narrowed. In severe cases the lumen may be entirely occluded, and then the vessel appears as a narrow white branching ribbon.

Obstruction to the general circulation is shown in slight cases by congestion, swelling, and tortuosity of the veins alone; in severer cases the arteries are diminished in calibre and unduly pale; whilst in all forms of obstruction hæmorrhages are frequent both from arteries and veins.

Retinal hæmorrhages have a different appearance according to their situation and extent. The smallest hæmorrhages remain confined to the nerve-fibre layer of the retina, through which the vessels run, and then appear as narrow red streaks with occasional bulgings, which often give them a "*flame-shaped*" character. More extensive hæmorrhages break down the intervening structures, and appear as red splashes of irregular shape and size. In the macular region a peculiar variety of hæmorrhage sometimes occurs, characterised by its semi-circular or crescent-shaped form, and known as a **subhyaloid hæmorrhage**, from its supposed position anterior to the retina and beneath the hyaloid membrane of the vitreous. It is doubtful if "subhyaloid" is a correct designation. Herbert Fisher* has recorded the histology of a typical specimen of this sort, and conclusively showed that in his case the hæmorrhage occupied the most internal layers of the retina, bulging forwards the internal limiting and hyaloid membranes. Retinal hæmorrhages, when of an extensive character, may penetrate between the choroid and retina, and so be a cause of retinal detachment; whilst even small hæmorrhages are liable to rupture the hyaloid membrane and permeate the vitreous chamber.

Various results follow retinal hæmorrhages; in the slightest cases complete absorption without apparent damage to the retina may follow; but this is the exception. As a rule, irreparable damage is done; either the blood is absorbed, leaving an atrophic white patch to mark its site, or the blood-clot undergoes an organisation into connective tissue. An exception to this is subhyaloid hæmorrhage, in which, probably owing to its anterior position, the nerve-fibres escape destruction, and partial or complete restoration of sight may follow the absorption of the blood. A great danger in relapsing hæmorrhages is the onset of hæmorrhagic glaucoma induced by the increased intra-ocular pressure. In this case the eye is irreparably lost, and enucleation is the only remedy for the great pain and distress which the glaucoma causes.

HYPERÆSTHESIA of the retina, or undue sensibility to light, is one of the symptoms that follow overwork, especially if the eyes be myopic or hypermetropic. The patient complains of flashes of light, accompanied by a sensation of heat and fatigue. The eyes are intolerant of bright light, and frequently during the day they are spasmodically closed by gushes of hot tears, accompanied by a sense of grittiness and increased photophobia. The condition is common amongst certain trades—seamstresses, bootbinders, engravers, etc.,—who are often engaged for many hours at close work with an insufficient light, and who frequently suffer from chronic constipation. The latter in many cases forms a very powerful factor in the causation of these symptoms.

Treatment.—Rest of the eyes is imperative, especially from all occupation that requires close application of the eyes or a stooping position of the head. Mild counter-irritation in the form of small blisters to the temple or behind the ears, or a stimulating liniment, is

* 'Ophth. Hosp. Rep.,' xiv, ii, p. 291.

of service, and neutral-tinted protectors should be worn when the eyes are exposed to bright lights. As a local application, nothing is better than the cold douche applied to the eyes with the lids closed. Correction of refractive errors and the efficient treatment of constipation are both very important, and the remedies employed for the latter may be advantageously combined with tonics of iron or strychnine.

AMBLYOPIA (*ἀμβλῦς* = dull) is a term formerly applied to all forms of abnormal dullness or deficiency of sight, but is now restricted to those varieties of defective vision which are unaccompanied by any visible lesion in the fundus.

1. **Congenital Amblyopia** is often found in microphthalmic, or badly developed eyes, or in eyes which are highly astigmatic or hypermetropic. It is also met with in children who are mentally deficient.

2. **Amblyopia ex Anopsia**, or amblyopia from non-use, is the term applied to the defective sight often noticed in one eye when binocular single vision has been abolished for a long time. Such an eye very frequently squints; but it is still a matter of conjecture whether the amblyopia is a cause or effect of the squint (*see also* "Strabismus.")

3. **Hysterical Amblyopia**.—This is usually confined to one eye, but is occasionally bilateral (*see page 391*).

4. **Diabetic Amblyopia**.—Occasionally a *central* amblyopia, such as is seen in tobacco or alcohol poisoning, is the only ocular manifestation in diabetes. Diabetes is more commonly a cause of cataract or of inflammatory and hæmorrhagic effusions into the retina.

5. **Uræmic Amblyopia**.—Great loss of sight, sometimes amounting to complete blindness, may occur as the result of uræmia (*see page 340*).

6. **Toxic Amblyopia**.—Many drugs produce a central amblyopia. They have been collected into a common group, and their symptoms will be found described on *page 368*.

7. **Amblyopia from Loss of Blood**.—Excessive hæmorrhage, such as occurs in severe hæmatemesis or post-partum flooding, may be followed by loss of sight. This may be temporary, but occasionally persists from atrophy of the optic nerves.

8. **Colour-blindness**.—This defect has been described in treating of Colour-vision (*see page 49*).

9. **Chromatopsia or Coloured Vision**.—Occasionally patients complain of seeing everything coloured red after the extraction of cataract. (*see page 288*). Coloured vision is also a not infrequent accompaniment of optic-nerve atrophy (*see page 373*). It also occurs sometimes in the amblyopia that follows exposure to glare.

10. **Amblyopia from Exposure to Bright Light**.—The effects differ according to the length of exposure and the intensity of the glare. In the least severe cases exposure is followed by a temporary paralysis of the retina, evidenced by more or less complete blindness, and lasting a variable time, from a few seconds in cases of momentary exposure to several hours. Of this kind are the slighter cases of blindness following exposure to lightning flashes, or the glare from snowfields or desert sand, or the amblyopia from which lighthouse keepers not infrequently suffer.

When the light is very intense retinal symptoms are accompanied by a conjunctivitis which may be violent in character, and by erosions of the corneal epithelium. The latter occur in the worst cases of snow-blindness or blindness from exposure to electric light, such as the brilliant light of the electric drill. The conjunctival and corneal symptoms are usually delayed for some hours after exposure. At first there is anæsthesia, but as this passes off the patient is seized with agonising pain, lasting in bad cases for several hours, and caused by the reacting hyperæsthesia of the exposed corneal nerve terminals. This is accompanied by profuse lacrymation, photophobia, and a sense of heat and grit from the conjunctivitis.

The retinal symptoms in the worst cases may develop into a permanent central scotoma with atrophic and pigmentary changes at the macula.

Prolonged or chronic exposure to glare in tropical countries, especially when the constitution is weakened by ague or scurvy, is not infrequently followed by a chronic anæsthetic condition of the retina, evidenced by night-blindness (*see below*, "Nyctalopia"). The same effect is said to result from sleeping in the open air exposed to the rays of the moon.

The **treatment** of the acute forms consists of rest and the wearing of neutral-tinted protectors in tropical glares or snow; whilst for those who are habitually exposed to strong glares from the electric drill or molten metal, etc., spectrum-blue protectors, which cut off the red rays, are the best. Conjunctivitis and corneal erosions are to be treated on ordinary lines, the first severe pain being checked by the instillation of a weak solution of cocaine; whilst later on cold douching and soothing applications will be found of great comfort. Astringent lotions are not required unless the conjunctivitis prove obstinate, and should always be avoided if the corneal epithelium is eroded.

II. Nyctalopia (ὁ τῆς νυκτός ἀλαός, Tweedy), or night-blindness, is a loss of sight, varying in degree from dimness to almost complete blindness, after the sun has gone down. The symptom is due to *anæsthesia* of the retina, and results from organic or functional disorders. Nyctalopia from organic disease is a constant symptom of all forms of retinal inflammation or degeneration, and is especially marked in "Retinitis Pigmentosa" (*see page 346*). *It is only as a functional symptom that we have to consider Nyctalopia at this point.*

a. Epithelial Xerosis and Nyctalopia.—Mr. Arthur Benson (Dublin) was the first to draw attention to the frequent presence of night-blindness in children in an epidemic form, occurring usually in the spring and early summer in charity schools, those children being invariably attacked who had some other ailment or delicacy in addition. The night-blindness in many cases is accompanied by a peculiar form of conjunctival xerosis, characterised by a white, frothy-looking patch of variable size on the conjunctiva at each side of the cornea, in that part most constantly uncovered by the lids. It can be easily removed, but re-forms rapidly. The patch itself, and the conjunctiva under it, has an oily look, so that the tears form in droplets upon it as on a greasy surface (*see also page 125*).

b. Nyctalopia from Scurvy or Exposure to Privations.—During the Crimean war nyctalopia was frequent both amongst the soldiers and sailors from these causes, and we have seen several examples amongst sailors after a prolonged voyage, and frequently in association with scorbutic symptoms.

c. Nyctalopia from Glare.—This has already been referred to as one of the results of prolonged exposure to bright light in tropical countries, and it is especially apt to occur if the constitution is debilitated by ague, dysentery, or scurvy.

Prognosis and Treatment.—There can be no doubt that functional nyctalopia is purely a tropho-neurosis, a sign of failing innervation from loss of vitality. The clinical picture is unaccompanied by any objective ophthalmoscopic signs, but there is in all cases a history of defective nourishment or of debilitating illness. Functional nyctalopia is very amenable to suitable treatment. If there is any evidence of scurvy, an antiscorbutic diet should be prescribed, containing fresh vegetables with two or three oranges or the juice of one or two lemons daily. The citrate of potash (grs. xx) may be also given in water twice or three times a day, and if there is anæmia, the citrate of ammonia and iron combined with citric acid may be ordered.

If ague or remittent fever can be traced as a possible cause of the disease, quinine should be freely given, and continued for at least six or eight weeks. The eyes should be rested, and all exposure to glare or strong light avoided. We have tried keeping the patient in absolute darkness for a week at a time; but the relief was not sufficient to compensate for so long an exclusion from light. Blisters to the temples and behind the ears are perfectly useless; they only serve to irritate the patient, and do no good.

Hemiopia.—This is described in the chapter dealing with eye symptoms in nervous diseases (page 381).

RETINITIS.

Retinitis, or inflammation of the retina, generally arises from some constitutional cause, as syphilis or disease of the kidneys; but it may also be produced by over-use of the eyes before strong lights. It may occur as a secondary affection from obstruction to the retinal circulation, from orbital tumours, or from embolism, or from an extension of an inflammation of the neighbouring structures. So intimately associated are the retina and choroid in health, that it is difficult for one to be affected by disease without the other also participating.

Thus it is customary to speak of a **retino-choroiditis** or of a **choroido-retinitis**, and the first word in each case can be used to indicate the chief or primary focus of disease. In the same way the optic papilla very frequently shows an active participation in the inflammation, which may be then styled a **neuro-retinitis**.

In speaking, therefore, of the disease of the retina, it must not necessarily be inferred that only the retina is affected, but that it is the structure primarily involved, and the seat of the principal morbid changes.

General Symptoms.—The patient complains that he sees surrounding objects darkly, as though he were looking through a mist. He has to examine closely whatever he wishes to see correctly, and to use a strong light; in fact, from the dulled sensibility of the retina a deep impression is required. As the disease progresses, the field of vision becomes contracted, or portions of it are lost; and the darkness steadily increases until ultimately the eye is blind. The defect of sight is influenced by the part of the retina which is chiefly affected; when the peripheral portions are first attacked, the field of vision is contracted, but the impairment of sight is much less than when the region of the yellow spot is invaded by the disease. The external appearance of the eye is unchanged; there is nothing about it to strike the ordinary observer; it is only by the ophthalmoscope that the symptoms complained of by the patient can be explained.

Examined with the Ophthalmoscope, there is seen a change in the transparency of the retina, which is slightly turbid or milky, from a delicate film of exudation on its surface. There is often some swelling of the optic disc, its outline is indistinct, and looks blended with the surrounding parts. The veins are generally more or less distended and sometimes tortuous, and parts of them are here and there rendered less distinct, on account of the film which covers them. There may be extravasations of blood, or inflammatory exudation into the retinal tissue, which will appear as greyish-white spots.

The **prognosis** of retinitis, except when it proceeds from syphilis, is generally unfavourable. The prospect of recovery is diminished in proportion to the extent of the hæmorrhages and the amount of the inflammatory exudations. Nerve structure once destroyed is never replaced. It is only, therefore, when the exudations have been chiefly confined to the connective tissue of the retina that a favourable result will follow. When there has been neither hæmorrhage nor isolated grey spots of exudation, the eye may recover with fair sight. Retinitis may terminate in blindness from atrophy of the retina, or by its detachment from the choroid.

General Treatment of Retinitis.—This must, in the first place, be directed to the cause of the inflammation. Locally, counter-irritation in some form to the brow or temples, or leeches to the mastoid, are useful. Above all, complete rest for the eyes is always indicated, and this is best obtained by the patient abstaining from all close work and by the wearing of dark spectrum-blue glasses, which have the advantage of cutting off all rays from the red end of the spectrum.

ALBUMINURIC RETINITIS is so called because of its association with Bright's disease or with the albuminuria of pregnancy. It is liable to occur in all forms of Bright's disease, but is especially common in the later stages of chronic interstitial nephritis associated with hypertrophy of the left side of the heart and general arterio-sclerosis. At the same time ophthalmoscopic appearances similar to those seen in albuminuric retinitis have occasionally been noted in patients with perfectly healthy kidneys; and conversely, renal retinitis does not always produce the typical picture presented below.

Symptoms.—There are three forms in which this nephritic retinitis may occur.

1. It may gradually develop itself with the advance of the kidney disease. For a long time the patient may have complained of a general mistiness, everything appearing as if through a veil; or the impairment of vision may have been confined to one portion of the field, when suddenly the sight is discovered to be markedly worse. Such sudden loss of sight is probably due to retinal hæmorrhage, and is in proportion to the number, size, and locality of the blood-clots. In other cases the

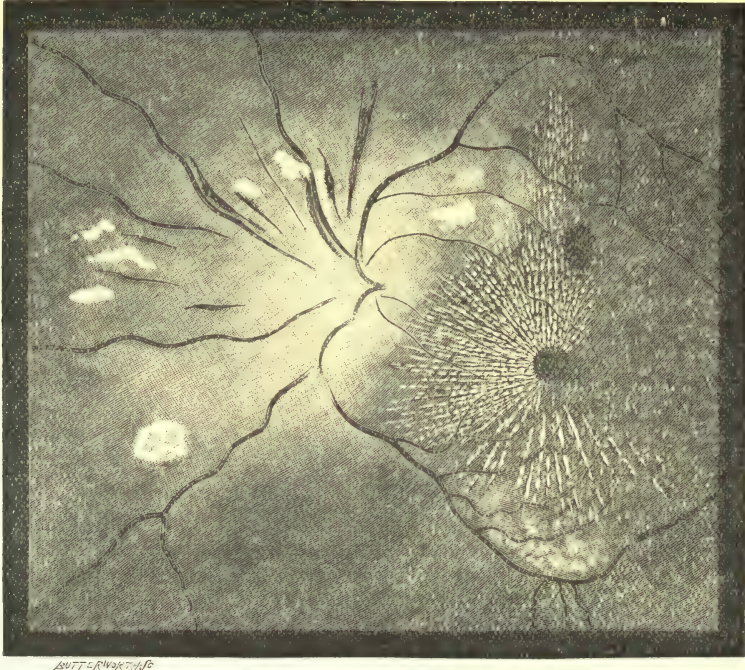


FIG. 159.—Albuminuric retinitis in its most typical form. The stellate macular figure is very well shown, and its silvery brightness, as compared with the soft woolly outline of the scattered patches of exudation, should be noted. The macula itself stands out sharply, and is of a much deeper colour than the surrounding retina. It is purely a contrast effect, and similar to that seen in embolism of the central artery. (See Fig. 164 and Text.)

patient may for a time be quite unaware that anything is wrong with the sight, although ophthalmoscopic examination reveals severe and typical changes in the fundus.

2. The **second** form of nephritic retinitis is dependent on uræmia, and occurs in the later stages of kidney disease, associated with suppression of urine, delirium, and convulsions. The loss of sight is extremely rapid, often complete, and sometimes permanent. In many cases there has been well-marked retinitis before the uræmic attack; but this variety of blindness has no ophthalmoscopic picture of its own, being due to acute toxæmia from uræmic poisoning. If the patient

survives the uræmic attack, the restoration of sight may be as rapid and complete as its loss, provided that no organic changes have taken place in the retina during the attack.

3. Nephritic retinitis occasionally occurs in women during pregnancy, who are suffering from albuminuria induced by the pregnant state. This form of the disease is frequently accompanied by retinal hæmorrhages, and both eyes may be affected by it. In one case under our care the sight of both eyes was so far destroyed by retinal hæmorrhages that only the perception of large objects remained.

Ophthalmoscopic Appearances.—These are limited to the peri-



FIG. 160.—Albuminuric retinitis. (From a case of Mr. Percy Flemming.) This represents another type of the disease taken at rather a later stage. The œdema has subsided considerably, and the star-shaped figure at the macula is represented by an irregular agglomeration of silvery points interspersed with minute hæmorrhages and speckled with pigment. The patient died very shortly after this picture was painted.

papillary zone. The optic nerve is slightly swollen and œdematous, with its margin indistinct and blending with the surrounding cloudy retina. Around the disc the retina looks of a greyish white, and the vessels as they pass to and from the optic nerve are in parts obscured by the exudation. Here and there irregular white patches with a soft woolly contour stand out prominently; whilst in typical cases the immediate region of the macula is transformed by the presence of numerous small, glistening silvery points, often arranged so as to form a kind of halo or stellate figure round the macula, which from contrast appears of a deep red colour. Retinal hæmorrhages are a constant

feature. They usually proceed from the capillaries, being small and flame-shaped, but larger irregular splashes are not infrequent. The retinal veins are engorged and tortuous from the obstruction to the circulation. The arteries are also tortuous, and frequently present the silver-wire appearance characteristic of fibro-sclerosis (*see* page 334).

Pathology.—Albuminuric retinitis is essentially a symptom of long-standing disease of the kidneys when vascular changes are far advanced. There is general œdema of the retina over the diseased area, causing backward pressure and rupture of the sclerosed arterioles. The soft woolly patches result from plaques of coagulated exudation in the deeper layers of the retina, particularly the outer nuclear layer, whilst the silvery streaks and dots are generally held to be due to fatty degenerative changes in the sustentacular tissue of the retina (Müller's fibres). Both eyes are invariably affected, though one may be attacked before the other. The disease, though naturally chiefly confined to old or elderly subjects, may occasionally occur in children or young adults suffering from chronic renal disease. We have had two cases in our practice in which the patients were under fourteen years of age. In one, changes in the vascular system were well marked, and there was a suspicion of inherited syphilis; but in the other case the patient was suffering from chronic tubular nephritis, and vascular changes were not prominent. In both, death followed in a few months after the first onset of retinal symptoms.

Diagnosis.—This must be made by attention to collateral symptoms. The silvery stellate figure near the macula is characteristic; but at the most we can only assume from the clinical picture that the case is probably renal.

Prognosis.—From what has been said it will have been judged that the prognosis is very unfavourable when the retinitis occurs in chronic renal disease; and this is the case. The supervention of albuminuric retinitis is a sure symptom of the final stage of renal disease. The majority die within a year, from uræmia or cerebral hæmorrhage, etc. Of the rest some live for two years, but only a few, although treatment and the surroundings of the patient undoubtedly influence the prognosis as to the duration of life. When the retinitis occurs during pregnancy the prognosis, though serious, is decidedly more favourable, and the patient may completely recover under appropriate treatment.

Special Treatment.—As the state of the eyes is secondary to and dependent on the disease of the kidneys, the treatment must be constitutional, and those remedies should be selected which are suitable for the renal affection from which the patient is suffering. A farinaceous diet should be ordered, and the bowels should be made to act once daily, the pulv. jalapæ comp. or some hydragogue cathartic being given early in the morning when necessary. The preparations of iron usually do good, and of these the tinct. ferri perchlorid. is perhaps the most useful. The object to be obtained is to relieve the kidneys by promoting the action of the skin and the bowels. Mercury in any form in nephritic retinitis should be strictly avoided. If the eye is painful, a leech applied to the temple will often give ease, and it may be repeated from time to time. The patient should also avoid stooping,

as it favours the flow of blood to the eyes, and thus renders them more liable to retinal hæmorrhages.

When there is nephritic retinitis in pregnancy, our own feeling is that premature labour should be brought on, with the hope that, in sacrificing the life of an unborn child, we may save the more valuable life of the mother.

SYPHILITIC RETINITIS.—There is one form of retinitis which is undoubtedly due to syphilis. The history of the case and certain ophthalmoscopic appearances mark its specific origin. It usually occurs during the tertiary period of syphilis, when nodes form on the bones, and the patient has pains in his limbs and joints; when, in fact, the constitution has been thoroughly imbued with the poison. This form of retinitis has been observed in the inherited as well as the acquired form of syphilis.

Symptoms.—A gradual failure of the sight extending over the whole field of vision. The pupil is sluggish and inclined to be dilated. There are no external manifestations to account for the great loss of sight. A past history may reveal syphilis, or there may be local evidences of the disease which will render a searching interrogation unnecessary.

Examined with the Ophthalmoscope.—There is usually turbidity of the vitreous, and a diffused greyish haze of the retina extending from around the optic disc, which is blurred and slightly swollen; whilst here and there are seen buff-coloured patches of exudation. The absence of any hæmorrhagic spots is also to some extent characteristic of syphilitic retinitis.

Pure and uncomplicated syphilitic retinitis is a rare disease; it is usually combined with exudative choroiditis, and to the joint affection of the retina and choroid the term "**syphilitic choroido-retinitis**" has been well applied. (*See also* "Exudative Choroiditis," page 321.)

The **prognosis** of retinitis syphilitica is more favourable than that of any of the other forms of retinitis. When seen sufficiently early the disease will generally yield to appropriate treatment, and a great amelioration of the symptoms will usually follow, and in some cases a complete restoration of sight.

Special Treatment.—The iodide of potassium and the preparations of mercury are the drugs to be relied on for the relief of this disease. When the progress of syphilitic retinitis is very rapid, it is desirable to get the patient quickly under the influence of mercury, and this may be readily accomplished by rubbing half a drachm of the unguent. hydrarg. into the axilla or inner side of the thighs night and morning until the gums are slightly affected, when its effects may be continued without being increased by diminishing the frequency of the inunction. If the patient is feeble, quinine may be given during the exhibition of the mercury; but if not, small doses of the iodide of potassium two or three times a day will be more useful. In some cases very good results will follow the use of Lee's mercurial vapour bath (F. 3). The patient should commence his fumigations with gr. x of calomel, and continue them every night, the surgeon keeping a careful watch that he does not

become too much affected by them. The baths should be discontinued or intermitted if the gums become spongy, and care should be taken that the patient guards against all risks of exposure either during or after their administration.

RETINITIS PROLIFERANS.—This is a rare disease to which attention was first called by Manz,* consisting in the formation of strands of connective tissue, which project forwards from the retina into the vitreous, and are frequently vascularised by new blood-vessels. The condition seems always to arise in connection with retinal hæmorrhages, which precede or accompany the formation of the fibrous tissue. The retina itself is thickened and partially disintegrated over the diseased area, and sometimes detached in places. The pathology of this condition is somewhat in doubt. Probably it is chiefly due to organisation of the fibrin of the blood-clot, though why this should occur in some cases of retinal hæmorrhage and not in others is uncertain. Retinitis proliferans is most usually associated with some general disease, such as syphilis, diabetes, gout, or Bright's disease, and then frequently involves both eyes; but it may also follow a hæmorrhage which is the result of injury, and we have seen this vascular connective tissue encapsule a foreign body in the vitreous. The prognosis is unfavourable, as the newly formed tissue is incapable of absorption.

Treatment (see "General Treatment of Retinitis," page 339).

RETINITIS CIRCINATA.—This is another rare form of retinal disturbance associated with retinal hæmorrhages. It was first described by Fuchs,† and is characterised by the presence of white plaques grouped so as to form an irregular white encircling band round the macula. It is not to be confused with the stellate figure round the macula seen in albuminuric retinitis. In the latter disease the white streaks run radially from the macula as a centre, and do not exhibit the groups or clusters of white plaques seen in retinitis circinata. The macula itself usually exhibits pigmentary changes, and central vision is much reduced. The pathology of the condition is doubtful. The plaques may be due to organisation of blood-clot. Ammam‡ has, however, recently published the result of a microscopical examination of a case. He found blood-clot in various stages of organisation, and cells undergoing fatty degeneration, and to the latter he attributes the appearance of the white plaques.

Treatment (see "General Treatment of Retinitis," page 339).

AMENORRHEIC RETINITIS.—Irregular or suppressed menstruation is sometimes the cause of a hæmorrhagic neuro-retinitis. The ophthalmoscope shows scattered hæmorrhages, some of which may be of large size and involve the vitreous, together with cloudy œdema of the retina and papilla. The hæmorrhages are very apt to recur, and

* 'Graefe's Archiv,' vol. xxii, 3, p. 229.

† Ibid., vol. xxxix, 3, p. 229.

‡ 'Arch. of Ophth.,' xxvii, p. 203.

may entirely destroy the vision or induce hæmorrhagic glaucoma. Sometimes the symptoms run a very acute course, the attack being ushered in by intense headache and vomiting, and running on to blindness in a few days or weeks, as in a case under our care, when little but light perception was left in either eye fifteen days from the onset of symptoms. The ophthalmoscope showed that there was considerable obstruction to the circulation, and there were evidences of increased intra-cranial pressure. Under the influence of 10-grain doses of iodide of potassium the uterine functions were restored, and the sight in great measure was gradually regained.

Special Treatment.—Every endeavour should be made towards re-establishing regular menstruation. Sometimes, as in the case just mentioned, excellent results follow the administration of the iodide of potassium given in 10-grain doses twice a day in water. It has then acted as a powerful emmenagogue. Notice should be taken whether the amenorrhœa is due to anæmia or congestion. If the former, tonics of quinine and iron, or iron and ergot may be ordered, but at the same time some aloetic pill should be prescribed, to ensure the regular daily action of the bowels. If the suppression is due to congestion, the bowels should be freely acted on by a brisk purgative, and in some cases small doses of podophyllin given every other or third night do good. When the sight is rapidly failing and there is much pain in the head, the inunction of the unguent. hydrarg. night and morning, so as to get the patient quickly under its influence, is productive of great good. As soon as the gums are spongy the frequency of the inunctions must be diminished, but a slight mercurial action should be kept up for two or three weeks. (*See also* "General Treatment of Retinitis," page 339.)

DIABETIC RETINITIS is a somewhat rare complication of diabetes. There are rarely distinctive features to mark this from other forms of retinal inflammation, but sometimes there are silvery punctate markings about the macular region resembling those seen in albuminuric retinitis, whilst hæmorrhages are also frequent. The exudation may be excessive, and the vitreous may share in the general inflammation. Retinitis is a complication usually only seen when the disease is of long standing; but it does not imply a debilitated condition, for it may occur in very chronic forms of the disease when the patient is well nourished and the glycosuria small. The *prognosis* is unfavourable from the very nature of the cause, and if one eye only is affected at first, we must dread a similar affection of the other. Sight may be completely lost by frequent hæmorrhages, and in one case under our care the hæmorrhages were followed by well-marked "retinitis proliferans."

Treatment.—This must be on the usual dietetic lines. If the patient is already under treatment when the retinal symptoms supervene, there is little hope of amelioration. (*See also* "General Treatment of Retinitis," page 339.)

LEUKÆMIC RETINITIS.—Several cases of retinal inflammation occurring in leukæmia have been reported. The inflammation is

essentially of a hæmorrhagic type. Ophthalmoscopically the fundus presents a characteristic pale yellow or orange reflex, due to the condition of the blood, whilst the veins are swollen and tortuous, and the fundus splashed by numerous hæmorrhages of various sizes and shapes. The outline of the papilla is probably hidden by œdematous swelling, and may be streaked with ecchymoses. The hæmorrhages are recurrent, so that sight may be completely destroyed in course of time, or hæmorrhagic glaucoma induced.

Treatment (*see* "General Treatment of Retinitis," page 339).

RETINITIS IN PERNICIOUS ANÆMIA.—A few cases of neuro-retinitis, generally accompanied by hæmorrhages, have been recorded. There is no typical picture, but in a few instances there have been silvery streakings about the macula, and a stellate figure closely resembling the appearance seen in albuminuric retinitis.

Treatment (*see* "General Treatment of Retinitis," page 339).

MALARIAL RETINITIS.—In severe cases of malaria, neuro-retinitis with disseminated hæmorrhages may attack one or both eyes (*see also* "Neuro-Retinitis").

Treatment (*see* "General Treatment of Retinitis," page 339).

SUPPURATIVE RETINITIS may occur rarely from a septic embolus plugging the main retinal artery in septicæmia from any cause. Much more commonly the condition is secondary to a primary inflammation of the uveal tract (*see* "Panophthalmitis").

RETINITIS PIGMENTOSA, or pigmentary degeneration of the retina, is so called because proliferation of the retinal pigment cells is its most conspicuous feature.

Pathology.—The disease is most commonly congenital, or commences in early childhood. A few cases where the onset has occurred in adult life have, however, been recorded. Both eyes are always affected, and to a similar extent, although to this there are occasional exceptions. The disease often shows a strong family predisposition, and several members of one family may be affected. It is also frequent amongst deaf mutes, and amongst children who are the offspring of marriages between blood relatives.

Scarcely a sufficient number of anatomical investigations have as yet been carried out to absolutely confirm the precise nature of this disease. Certainly the term "retinitis" is wrongly applied, because at no period of the disease are any signs of inflammation present, and the affection must be regarded as purely of a degenerative nature. In all cases atrophy of the nervous elements of the retina with sclerosis of the vessels has been found, whilst in many cases the choroid is distinctly affected. The consensus of opinion is in favour of the disease being primarily vascular in origin, consisting of a chronic endarteritis and periarteritis affecting both choroidal and retinal vessels, and causing gradual obliteration of the lumen and secondary wasting of the nervous elements from defective nutrition. In retinitis pigmentosa the deposit

of pigment is peculiarly characteristic in its distribution, and taken in company with the other features of the disease forms a picture which, as a rule, presents very little difficulty in diagnosis.

Symptoms.—The characteristic signs of this disease are torpidity or diminished sensibility of the retina, a gradually increasing contraction of the field of vision, and a peculiar deposit of pigment in the retina. The first symptom which generally attracts attention is the inability to walk about in a dim light. The patient suffers more or less from nyctalopia, or night-blindness; by day his *direct* vision is good, but after dusk it is considerably impaired. The contraction of the field of vision, which takes place from the periphery towards the centre, increases almost imperceptibly year by year, but the direct central sight may remain for a long period unchanged. In many cases the disease will appear to remain stationary for several years, but in the end central vision is gradually abolished, and the patient, usually about middle life, becomes quite blind. Opacities at the posterior pole of the lens are



FIG. 161.—Retinitis pigmentosa. The corpuscular-shaped pigment patches are seen advancing from the periphery. The disc is very pale, and the vessels attenuated.

apt to complicate the later stages of the disease, and in a few cases chronic glaucoma has supervened.

Examined with the Ophthalmoscope, the retina presents a very striking appearance. Sprinkled in an apparently irregular manner, are large deposits of pigment; some of the spots are stellate, or of a spider shape with many small offshoots; others look like mere granules, either congregated together in groups or scattered about indifferently. This deposit commences in the periphery and gradually extends towards the centre as the disease progresses.

When more carefully examined, the deposits of pigment seem in places to follow the course of the retinal vessels, parts of which they will overlay. The retinal arteries appear small, and in long-standing cases thread-like, from slow obliteration of the lumen and consequent narrowing of the blood-column. Frequently the vascular changes

are as well marked in the choroid as in the retina, so that the capillary network forming the chorio-capillaris is so wasted that the deep choroidal circulation is exposed to view, and its vessels appear pale and bounded laterally by white lines, indicative of the thickened condition of their walls. The disc has a peculiar waxy look, which in cases of long standing passes into the dull white hue of confirmed atrophy.

Treatment.—Little if any benefit is to be derived from medicine, and the patient gets slowly worse in spite of any drugs. Hypodermic injections of strychnia and the use of the constant current have been tried, and benefit has followed in some cases. The maintenance of the patient's general health is important, and iron, arsenic, and strychnine are all useful. The use of the eyes must be restricted, and all work requiring accommodative effort should be avoided. Curved neutral or spectrum-blue glasses should be worn in the open air or bright sunlight, as they afford rest and protection from wind; but the shade must not be too dark, on account of the nyctalopia.

RETINITIS PUNCTATA ALBESCENS (Mooren).—Under this term more than one rare condition has been described. It is, however, applicable to a now well-recognised class of cases differing in some particulars from Mooren's original description, and which are characterised by a history of nyctalopia extending from early childhood, general contraction of the visual fields, some central amblyopia and loss of colour-sense, and the appearance in the fundus of numerous minute and discrete white dots, which seem to lie in the deeper layers of the retina, and which are chiefly aggregated in the more central portions of the retina between the equator and the disc. Both eyes are affected, and the disease tends to become stationary.

An important point is the family predisposition, which seems to be very general, and the frequent history of consanguinity between the parents.

It will be seen that the disease bears a striking resemblance in its clinical history and subjective signs to retinitis pigmentosa, to which it is probably closely allied in being a degenerative and not an inflammatory affection.

In this country our practical acquaintance with this rare disease depends on the information afforded by Nettleship* in two most interesting papers, and on a case reported by the late John Griffith.†

DETACHMENT OF THE RETINA.

Retinal detachment may be caused—

1. **By the extreme elongation of the coats of the eye which occurs in severe cases of myopia**, when the retina, being less extensible than the choroid, is in parts separated from it, and the intervening space is occupied by a serous fluid.

2. **By a diminution in the bulk of the vitreous**, so that the

* 'Trans. Ophth. Soc. U.K.,' vol. vii, p. 301, and vol. viii, p. 163.

† Idem, vol. xvii, p. 51.

retina, losing its due amount of anterior support, gradually becomes loosened from the choroid, and, falling forward, is at first partially and ultimately completely detached. This change may be induced by disease, but frequently it is the result of a penetrating wound of the eye, which has been either accompanied by a loss of vitreous or by hæmorrhage into its substance.

3. **By Hæmorrhage between the Choroid and Retina.**—This may occur in retinitis or glaucoma; or it may be caused by blows on the eye. In most cases the blood-clot is ultimately absorbed, but the retina remains detached.

4. **By Serous Effusion between the Choroid and Retina.**—This may occur in a normally shaped eye without any stretching of the posterior coats, as in myopia, or without any previous separation having been effected by hæmorrhage. In some instances it may possibly be due to disease of the vitreous resulting in a change of its structure and a lessening of its bulk; but in many cases no satisfactory cause for the detachment can be detected, and it is therefore ascribed by some to inflammatory action, of which there is little or no evidence.

5. **By the Presence of an Intra-ocular Tumour.**—As the growth advances the retina is carried in front of it, and the detachment increases with the progress of the disease.

Detachment of the retina may be partial or complete. In a large majority of cases the detachment is placed somewhere in the lower portion of the fundus. This is not necessarily the site of origin, for a detachment may originate at any spot; but when the separation occurs above, it invariably tends by force of gravity to filter downwards; so that, if we see an upper detachment, we may, provided that it is not due to a new growth, be pretty certain that it is of fairly recent occurrence. It usually occurs in one eye only, but both may suffer if the separation has been produced by causes which equally affect the two eyes, as in cases of extreme myopia. The tension of the globe is as a rule slightly diminished when there is a simple detachment with subretinal effusion; but if the displacement is due to a choroidal tumour, the tension is usually increased.

Symptoms.—It is often very difficult to ascertain from a patient the early symptoms of a displaced retina—they have either passed unnoticed, or, in the lapse of time, have been forgotten. Some indications of retinal irritation are, however, the general precursors of the detachment—the patient is frequently troubled for some weeks previously with the occasional and sudden appearance of bright flashes or scintillations, or of circles of fire, etc.; or with floating muscæ and dimness of vision. When the detachment has occurred the patient complains of loss of vision in one direction. Thus with the affected eye he may be only able to see a portion of the object he looks at, a half or a quarter of it being quite dark; or, if the loss is central, the point on which he directs his eye is blank, whilst he can see on each side of it. He complains also of a waving up and down with the movements of the head. This is caused by the floating to and fro of the detached portion, and is recognised by the part of the retina still

in situ. Another symptom often mentioned is that objects appear bent, twisted, or in some other way distorted, and is no doubt due to some disarrangement of the layers of a portion of the retina which is loosened, though not yet separated from the choroid.

Occasionally an eye with detached retina becomes glaucomatous and very painful. The presence of an intra-ocular tumour may then be strongly suspected.

Examined with the Ophthalmoscope.—The detachment is best seen by *direct* examination. The displaced retina quickly loses its transparency, and then appears as a bluish-grey film, bounded by a sharp line, on one side of which is the bright expanse of the choroid, shining through the transparent retina *in situ*; and on the other this semi-opaque grey web, which is bulged slightly forwards towards the vitreous. The alteration in the levels of the detached and still united portion of the retina is estimated by convex lenses as described on page 39, and if we trace the retinal vessels from the optic nerve we shall note that they seem to be suddenly bent when they arrive at the line of detachment. If fluid occupies the subretinal space beneath the

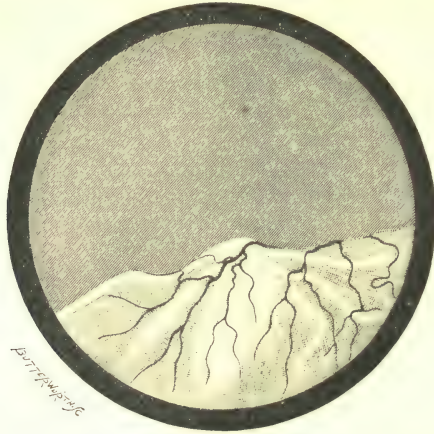


FIG. 162.—Detachment of the retina. (After Haab.)

detachment, sudden movements of the eyes will cause oscillations of the detached portion, of which, as already stated, the patient is often conscious.

Diagnosis.—This is easy when the separation of the retina from the choroid is complete, but when the retina is rather loosened or wrinkled than absolutely detached the diagnosis becomes exceedingly difficult. This condition is recognised by a slight opacity of the retina at one spot, and by noting the appearance of the vessels, which seem to stand out at one point and to be lost in the shade at another, as they rise or fall in their passage over the foldings of the loosened retina. When the lens is cataractous, the detachment of the retina cannot, of course, be seen by the ophthalmoscope, but its presence may be inferred by the patient's loss of power to project light over a large portion of the visual field. It is possible for vitreous opacities to be mistaken for

a detachment when dense, fixed, circumscribed, and homogeneous in character. The diagnosis will often be aided by observing at some chink the red glare of the fundus behind the opacity. The differential diagnosis between a serous detachment and a detachment due to an intra-ocular tumour has already been discussed on page 331.

The **prognosis of detached retina** is very unfavourable. The tendency is for the disease to extend and more retina to become detached, until at last the eye is blind. The most favourable cases are those in which there is a limited detachment, the result of an injury, probably a small effusion of blood between the choroid and retina. A blind spot in the field of vision will always remain, but the rest of the retina may retain its functions unimpaired. Cases occur where the subretinal fluid disappears, and the retina, having again fallen back to its place, still retains some power of sight, but they are exceptional.

Treatment.—Detachment of the retina is very intractable, and generally uninfluenced by medicines given for the purpose of procuring absorption of the subretinal fluid. A spontaneous cure or arrest of the disease has occasionally occurred from the accidental laceration of the retina, and the escape of the fluid into the vitreous. The knowledge of this fact induced Graefe and Bowman to endeavour to establish artificially a permanent rent in the detached portion of the retina, through which the fluid could extravasate into the vitreous. Examination should first be made with the ophthalmoscope to determine the exact position of the detachment.

The Operation may be thus performed:—

The lids being parted with a spring speculum, a needle should be introduced through the sclerotic at a point where it will perforate the detached portion of the retina at a prominent part. A second needle is then to be inserted at a short distance from the first, and so directed that its point shall penetrate the retina at or close to the same spot. To avoid the risk of wounding the lens in the passage of the needles, they should be thrust through the sclerotic nearly vertically. A rent is now to be torn in the retina by separating the points of the two needles. There is generally an escape of the subretinal fluid by the side of the needles during the operation, and frequently in a sufficient quantity to infiltrate a considerable extent of the subconjunctival tissue. The fluid is generally of a yellowish colour, and when tested yields a large quantity of albumen.

Instead of the above operation, a "**scleral puncture**," as described on page 244, but placed over the site of detachment, may be tried.

After either operation the patient should be kept very quiet on his back with a bandage over both eyes for at least a week, and the head steadied between sand-bags. At the end of this time one eye may be uncovered, but the horizontal position should be maintained strictly for another month or more.

As the treatment, to be beneficial, must be rigorously enforced, it

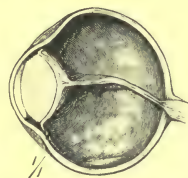


FIG. 163.—Appearance of an eye in which the retina is completely detached. The coarct retina is seen as a horizontal band formed of two lateral folds which are still attached at the ora serrata and optic disc.

will be scarcely possible to prolong it over six weeks, for it proves intensely irksome and wearisome; but when the patient is allowed once more to move about, all severe physical exercise or occupation requiring a stooping position, or the use of the accommodation, should be forbidden for a long period—at least six months,—and the patient be made to wear spectrum-blue glasses constantly. If, at the end of three weeks' treatment, no improvement has resulted, the case must be regarded as hopeless, and the detached portion of the retina as lost beyond recovery. Unfortunately, even in cases where the retina falls back and some sight is restored, the improvement is apt to be temporary, fresh detachment taking place, in spite of the most careful treatment, when the patient resumes his ordinary daily life again.

In a fair number of cases re-attachment of the retina has followed prolonged rest in the horizontal position without any operation, and some surgeons have found benefit from a diaphoretic course by hypodermic injections of pilocarpine.

Operative measures are only called for when the detachment is recent. Detachments of long standing can only be treated by combating the cause so as to prevent further separation if possible. Even in recent cases operative measures have met with so few successes that they often scarcely justify the risks of intra-ocular hæmorrhage and inflammation, slight though they be, entailed by the scleral puncture. Our own opinion is that operative treatment should be reserved for cases of serous effusion without apparent cause, or recent traumatic detachments, more especially in either case when the area of distinct vision is imperilled or lost; whilst in those cases where detachment is the result of long-standing disease such as myopia, we shall best consult the interests of the patient by the purely palliative and protective measures already indicated.

CONCUSSION OF THE RETINA.—The effects of blows upon the eye may be exhibited in the retina in four different ways:

1. Hæmorrhage into its layers with or without hæmorrhage into the vitreous.

2. Detachment of the retina.

3. A peculiar transient cloudiness of a portion of the retina called by Berlin,* who first described it, "*commotio retinae*," and ascribed by him to œdema. The cloudiness usually lasts for two or three days, and then disappears without leaving any ill effects. The retinal signs are associated with reduction of sight, episcleral congestion, and contraction of the pupil, which fails for a few days to respond to atropine. Denig,† who has made experiments on rabbits, attributes the symptoms to the vitreous being driven into the internal layers of the retina by the concussion.

4. "HOLE" AT THE MACULA.—The term is applied to a brilliantly red depressed patch, circular or oval in outline, occupying the macula,

* 'Klin. Monats. f. Augenh.,' xi, 1873, p. 42.

† 'Arch. Ophthalmology,' xxvi, 1897, p. 377.

and usually about half the size of the papilla. Some cases seem undoubtedly to be holes in the retina caused by its detachment at the macula, and in these there has also been extensive detachment of the surrounding retina. In others, again, whilst the macula presents the same ophthalmoscopic appearance, the patch is not so depressed and the surrounding retina is not detached. In these cases central vision, though reduced, is not usually completely lost, as in cases of the former category. The exact nature of the lesion has yet to be discovered. A very interesting paper and collection of cases has been published by Ogilvie.*

DISEASES OF THE RETINAL CIRCULATION.

EMBOLISM OR THROMBOSIS OF THE CENTRAL ARTERY OF THE RETINA is a cause of sudden and complete blindness accompanied



FIG. 164.—Embolism of the central retinal artery. The cherry-red spot at the macula is very apparent, and is seen to be surrounded by a halo of œdema. There is some œdema about the papilla. The arterial blood-column is almost but not completely obliterated. The patient, an old man, had bare light perception.

by a characteristic ophthalmoscopic picture. The patient gives a typical history of instantaneous loss of sight in one eye, or of going to bed well and waking up blind in the morning. If the eye is examined a few days after the accident the optic disc appears blanched, with hazy outline, the arteries reduced to the size of threads, and the veins also much diminished. The retina looks grey and bloodless, except in the neighbourhood of the macula, where a clear view is obscured by whitish œdema, in the centre of which the fovea often stands out as a brilliant red spot (*cherry-red spot*), an appearance which has been ascribed either to a foveal hæmorrhage or, more reasonably, to a con-

* 'Trans. Ophth. Soc. U. K.,' vol. xx, p. 202.

trast effect in colour, the retina being thinnest at the fovea, and so permitting the red reflex of the choroid to shine through at this point. The exudation about the macula and disc gradually passes away, and with it the striking red patch at the macula also disappears, leaving the nerve typically atrophic and the retina universally grey and bloodless. Not infrequently the circulation is in part gradually restored, its return being in some cases marked by small hæmorrhages, whilst in the earliest stages the blood-stream may be represented by short broken columns moving in a jerky way with the pulse. The retina, however, speedily perishes, so that the restoration of the circulation is seldom followed by any improvement in sight, and the arterial branches that remain shut off from any blood-stream, soon become converted into white threads. The embolus, instead of plugging the main trunk, may only implicate a branch of the artery, in which case the affected area will be represented by a scotoma of variable size; whilst in a few cases some vision is retained, owing to a portion of the retina being supplied by a



FIG. 165.—Thrombosis of the central retinal vein. From a case of a young girl with aortic stenosis. (See Text.) The papilla is hidden by enormous masses of exudation. The large tortuous vessels, hidden in places, are the branches of the central retinal vein. The arteries, which look very small by comparison, can be seen in places running in almost straight lines.

cilio-retinal vessel, instead of by a branch of the central artery itself. The symptoms produced by thrombosis are similar to those caused by embolism, and the one condition cannot be diagnosed from the other.

The **prognosis** is absolutely unfavourable.

Treatment.—Massage of the eye after rendering the eye anæsthetic with cocaine has had favourable results in some cases. To be of any use, it must be tried soon after the onset of the symptoms, and should be persevered with once or twice daily for a few minutes during the first few days after the accident. The object of the massage is to break up the embolus, and by driving it into the small arterioles to restore the circulation through the main trunks. As a rule, no treatment is of

any avail in restoring the sight, though we can assure the patient that it is most improbable that a similar accident will affect the other eye.

THROMBOSIS OF THE CENTRAL VEIN OF THE RETINA or one of its branches is a rare accident, and usually occurs in oldish people, though we have seen one case in a girl, aged 25 years, who suffered from aortic stenosis. The onset is sudden as in arterial embolism, and with the ophthalmoscope the retinal veins are seen to be enormously swollen and tortuous, whilst here and there little ruptures of their coats have taken place, permitting extravasations of blood. The outline of the disc is completely lost by serous exudation, which spreads in whitish plaques into the surrounding retina, and in places hides the vessels from view. The hæmorrhages are apt to increase in number, and may be so profuse as to rupture into the vitreous and destroy vision, or even the eye itself, by causing secondary glaucoma, an accident which happened in the case above referred to. In our own case we had the opportunity of verifying the diagnosis after enucleation.

The **prognosis** as to recovery is unfavourable. If only a branch of the vein is affected, the patient may retain useful sight, but if the main trunk is plugged, recurring hæmorrhages will probably soon destroy the vision.

Treatment.—No local treatment is of any avail. It is of importance to pay attention to the patient's general condition, not so much with the hope of saving the affected eye, but if possible to avert a similar accident to the other.

ANEURYSMAL DILATATIONS of the retinal artery are very rare, but may occur as miliary dilatations along the smaller branches in atheromatous subjects, or as a single sacculated aneurysm of one of the main trunks, whilst a few cases of arterio-venous aneurysm have also been recorded after injury.

RETINAL APOPLEXY.—Under this term are grouped cases of retinal hæmorrhage, unaccompanied by inflammatory conditions or disease of the eye itself, which occur as the result either of disease of the vessel walls, as from atheroma, or from abnormal conditions of the circulation induced by congestion of the portal circulation, heart disease, or by irregular or suppressed menstruation. In this category may also be placed cases of retinal hæmorrhage in young people, who, without any evidence of disease, exhibit a morbid tendency to bleed, and who often show this predisposition by repeated attacks of epistaxis. Such patients are often, but by no means invariably, true instances of hæmophilia, and in them the liability to retinal hæmorrhage seems to be favoured if the daily employment necessitates a stooping position of the head.

A well-marked example of a case of this sort was that of a youth, æt. 19, who by employment was a currier. He went to bed one night after his usual day's work feeling quite well; but on getting up the next morning was so blind that he could scarcely find his way to the work-yard; and in about two hours he had to return home, as he had barely sufficient sight to guide himself about. The boy had suffered from repeated attacks of epistaxis, and only the week before had lost a large quantity of blood in this way. With the ophthalmoscope extensive retinal hæmorrhages were found in each eye.

Symptoms.—Occasionally there are the premonitory warnings of a disturbed circulation; the patient has attacks of giddiness and dimness of vision, which may last from a few seconds to a few minutes; he complains of pain in the head, or has bleeding from the nose; but in many cases the retinal hæmorrhage occurs suddenly, without any previous indication of existing disease. The suddenness of the loss of sight is one of the most characteristic symptoms. The patient may awake in the morning and find himself nearly blind with one or both eyes; or, whilst engaged at his usual occupation, a dark cloud, or, as some have described it, a red ball may seem to appear before the affected eye, and to gradually increase in size until the vision is either partially or completely lost. The impairment of sight produced by the hæmorrhage depends on the extent of the effusion and the locality in which it has taken place.



FIG. 166.—Retinal apoplexy. From a case of an old man with general advanced atheroma. The fundus is dotted with innumerable capillary hæmorrhages.

For the ophthalmoscopical appearances see “Retinal Hæmorrhages,” page 335.

The **prognosis** is always unfavourable, for although some improvement may be gained by the absorption of the clots, yet as the exciting cause remains, the hæmorrhage is very likely to recur. When the blood has been extravasated either into the vitreous, or formed a clot between the retina and the choroid, the prospect of regaining any sight is very slight. In such cases, as the blood is slowly absorbed the vitreous becomes fluid, the retina detached, and the globe soft. The prognosis is most favourable when there is only one clot, even though it be a large one, providing the surrounding retina be healthy, and there has been no extravasation into the vitreous.

Treatment.—The most important matter is to ascertain the exact cause, and by treating this to minimise as far as possible the danger of a recurrence of the hæmorrhage. Special inquiries, too, should be made as to the usual occupation of the patient, and if it is one that

involves much stooping, or work close to the eyes, or much physical exertion, it should, if possible, be changed. In a general way it is well to keep the bowels acting freely for a time, and for this purpose the bitter waters of Friedrichshall, Pullna, or Hunyadi Janos are very useful. No local application is of any benefit to the vision, but if the eye is hot and painful, a wet compress may be laid over the lids, or one or two leeches may be applied to the temple, and repeated if they afford relief.

CYSTIC DISEASE OF THE RETINA.

RETINAL ENTOZOA are very rare, but a good many cases of **Cysticercus Cellulosæ** have been recorded as an occasional cause of retinal detachment, and if left alone, of complete disorganisation of the eye. The parasite causes no subjective symptoms beyond the loss of vision, but generally furnishes a clinical picture by which its presence may be diagnosed. It appears as a raised bluish-white mass of circumscribed outline, with a characteristic spot of much whiter hue, which marks the site of the scolex. Sometimes slight tremulous movements may be

FIG. 167.

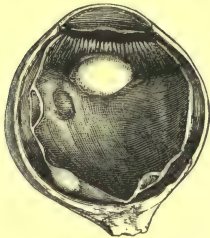


FIG. 168.



FIGS. 167 AND 168.—Cystic disease of the retina. In both cases the eye had been long lost from disease. In Fig. 168 the retina is turned forwards to show the cysts, which occupy its deeper layers next the choroid.

observed, and if seen are quite pathognomonic; but in most cases details are somewhat obscured by fine opacities in the vitreous of a peculiar membranous nature.

Prognosis.—If left alone the cyst will probably continue to grow, break through the retina into the vitreous, and completely destroy the eye.

Treatment.—The only treatment of any avail is to attempt to kill the parasite or evacuate the contents of the cyst by a suitable scleral incision, and this has been successfully accomplished in a few cases.

CYSTIC DEGENERATION of the retina is occasionally found in eyes that have been long lost. The retina may be studded with little cysts, sometimes growing to the size of a small pea. They are formed by separation of the retinal layers, and fatty granules are sometimes found in the cells lining the cyst walls (*see* Figs. 167, 168).

GLIOMA OF THE RETINA.

Glioma is the only form of tumour arising primarily in the retina. It springs from the connective tissue or neuroglia of the retina as a soft whitish vascular growth, and the internal granular layer is the most frequent starting-place. The growth may spread backwards, filling up the subretinal space, and pushing the retina before it (**glioma exophytum**); or more commonly it fungates into the vitreous chamber without detaching the retina, and causing absorption of the vitreous as it grows (**glioma endophytum**). In structure it is composed of small round or oval cells supported by a very delicate, scanty, and homogeneous intercellular substance. The older portions of the growth frequently undergo retrogressive changes, so that necrotic areas are formed, and in these changes the blood-vessels share, so that hæmorrhages are frequent. It is usually of rather slow growth, which may

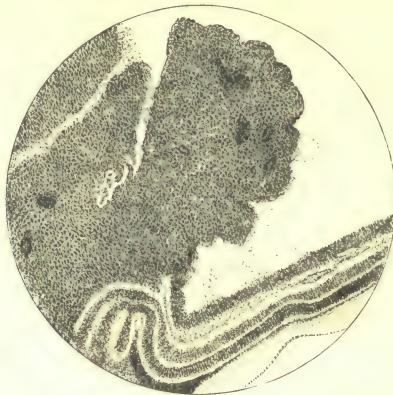


FIG. 169.—Microscopical section showing a glioma growing from the retina and sprouting into the vitreous chamber (**glioma endophytum**). On the right, healthy retina is seen, and the section shows well how the growth is commencing in the inner layers of the retina.

cover a period of one to two years before it completely distends the globe and bursts through the sclerotic and cornea; but when once it has ruptured through the globe it grows with extreme rapidity. The disease is very fatal, owing to its great local malignancy, tending early to spread along the optic nerve to the base of the cerebrum; so that even if the affected eye be removed early in the disease, local recurrences in the orbit, anterior cerebral lobes, or the opposite eye are very frequent. Metastatic growths in the viscera occasionally occur, but must be considered exceptional. Glioma is essentially a disease of early childhood, occurring most commonly before the third year, and in some instances being probably congenital, as in one of our cases in which the infant was six weeks old at the time of discovery. We have never met with glioma beyond the age of five years, but occasional cases of late onset have been reported.

Symptoms.—In the early stage of glioma there is no pain, and the

disease is usually first discovered by the mother or attendant noticing a bright yellow reflex from the fundus of the globe, and then, on closing the sound eye, it is found that the affected one is almost, if not completely, blind. This yellow reflex is commonly known as "*amaurotic cat's eye*," and the reason why it replaces the usual blackness of the pupil is explained on page 31. The refracting media are generally clear, so that the tumour can be closely examined, and on its surface will frequently be seen some new blood-vessels, and often a few splashes of hæmorrhage. As the disease advances there is an increased tension of the globe, and then the eye becomes painful, and the child restless, frequently crying and starting in his sleep. The lens and iris are pushed towards the cornea, and the pupil becomes dilated



FIG. 170.—Recurrent fungating glioma. From a case of a child *æt.* 2 years. The eye had been removed six months before. Two months later a recurrence occurred in the orbit, which was exenterated, but the growth rapidly recurred again. The present drawing was made three months after the second recurrence, and shows the extreme rapidity of growth. The child died within six months of the appearance of the second recurrence.

and inactive. At a later stage of the disease the lens becomes cloudy, the cornea dull, and the tumour bursts its way through the globe, and appears externally. It now seems to grow with an increased activity, and forms a fungating mass from which there are frequent recurrences of hæmorrhage, and the child dies, either worn out by pain and exhaustion, or from meningitis caused by an extension of the disease to the brain.

Diagnosis.—This is generally obvious; the lustrous growth behind the lens with new blood-vessels on its surface is quite characteristic. The condition most liable to be mistaken for it is a form of old circumscribed suppurative choroiditis, which has not gone on to complete disintegration of the globe, and in which the pupil is blocked by yellow membranous exudation simulating the yellowish reflex of glioma. This condition is commonly known as "*pseudo-glioma*;" but whilst the resemblance to glioma is striking, there are nevertheless important points by which the two conditions can be distinguished, and with care

a mistake will not often occur (*see* "Suppurative Choroiditis," page 324). Collins * mentions two cases in which a congenital vascular membrane behind the lens closely simulated the appearance of a glioma, and the eyes were excised on this supposition.

Treatment.—The only chance for the patient is an early excision of the globe, the optic nerve being divided as far back as possible; and should the two eyes be affected, both should be removed, provided the sight has been already destroyed, and the tumour has not burst through the external coats. Such an operation would afford the only hope for recovery, whilst at the same time it would save the patient much ultimate suffering. On several occasions we have been induced to remove the second eye, for the sole purpose of procuring some temporary relief from the excessive pain induced by the over-distended globe, and at a time when there was not the slightest prospect of arresting the disease. In each case the operation gave so much ease that, under similar circumstances, we should not hesitate to repeat it.

* 'The Anatomy and Pathology of the Eye,' p. 37.

CHAPTER XXII.

DISEASES OF THE OPTIC NERVE.

ANATOMY.—The optic nerve is derived from fibres supplied by both optic tracts. Invested by a pia-matral sheath and a few filaments derived from the arachnoid, it enters the orbit by the optic canal. At the entrance of this canal it receives a fibrous sheath from the dura mater, which wraps loosely round it, so as to leave a considerable space (*intervaginal space*) between it and the pia-matral investment. The arachnoid sheath is indistinct, and adheres fairly closely to the dura mater, so that the nerve-sheath is in free communication with the great subarachnoid space. The optic nerve runs forwards and outwards to the eyeball, where it pierces the sclerotic about 3 mm. to the nasal side of the centre. The intra-orbital course is about one inch in length and a little longer than the actual space between the apex of the orbit and the eyeball, so that free movements of the globe are permissible without stretching the nerve. At the globe the sheaths become blended with the sclerotic; the fibres part with their medullary coat, and the nerve, now consisting of a collection of axis-cylinders and reduced to about half its former size, passes into the globe through a series of sieve-like apertures in the sclerotic, known as the "*lamina cribrosa*." The central artery and vein of the retina enter the nerve about half an inch from the globe, the former being derived from the ophthalmic branch of the internal carotid, whilst the latter joins the ophthalmic vein to empty into the cavernous sinus. The intervaginal space above alluded to is in direct communication anteriorly with the lymphatic circulation of the globe through the lymph-channels of the choroid and Tenon's capsule.

The only bundle of fibres with a definitely located distribution is the *papillo-macular* bundle, which is distributed to the neighbourhood of the macula, or area of central vision. The location of this bundle is of great importance in retro-bulbar neuritis. At the papilla it lies on the temporal side, but behind the globe it quickly comes to occupy a central position. The bundle is a large one, consisting of about one fourth of the total number of fibres, and micro-

scopically can be definitely traced as a distinct group throughout the course of the nerve.

CONGENITAL ABNORMALITIES.

COLOBOMA OF THE OPTIC NERVE.—This is a rare deformity due to non-closure of the posterior portion of the foetal cleft, which at one time includes the rudimentary optic stalk (*see* “Development”). It takes the form of a deep excavation which extends both laterally and downwards, so that the papilla appears greatly enlarged, and presents a deep cup which extends almost to its margins. The cup is sharply excavated, and the vessels disappear over its edge just like they do in glaucoma. The whole papilla has a pale bluish-grey look, which is due to the cup itself being a simple hollow which contains no nerve-fibres,



FIG. 171.—Coloboma of the optic nerve. The darker spot on the extreme right indicates the position of the macula; whilst below the papilla is an incomplete coloboma of the choroid. (From a case of Mr. Herbert Parsons'.)

and at the base of which the white sclera is seen. The nerve-fibres are either aggregated round the margins of the cup, as seems to be the case in Fig. 171, or they may be collected together in the upper portion of the apparent nerve-head. The vertical extent of the coloboma may be gauged by the position of the macula, which instead of lying slightly below the inferior level of the papilla, will appear as though shifted upwards. In rare cases a coloboma of the optic nerve may be present with a coloboma of the choroid, and the two may be united.

Opaque Nerve-fibres.—These have already been described in “Diseases of the Retina” (page 333).

OPTIC NEURITIS.

This is of three kinds:

I. A primary inflammation of the nerve-fibres originating behind

the globe, either in the orbit or in the cranium, and commonly known as **Papillitis, or Descending Neuritis.**

2. A secondary inflammation starting within the eye and spreading from the retina to the papilla. This is known as "**Neuro-retinitis,**" or "**Ascending Neuritis.**"

3. A partial primary inflammation, involving only the papillo-macular bundle of nerve-fibres, and originating in the orbit, probably at or near the optic foramen. This variety is called **Retro-bulbar or Axial Neuritis.**

I. PAPILLITIS, OR DESCENDING NEURITIS.—The inflammatory changes are mainly confined to the optic nerve. It has been termed *descending* neuritis because it is the result of extra-ocular disease, and the inflammatory process descends along the trunk of the optic nerve to the papilla within the eye. It may be caused by tumours in the brain or in the orbit, or by intra-cranial syphilitic lesions, or by meningitis, hydrocephalus, lead-poisoning, or from any irritative disease within the skull. It may also arise from injuries to the head, coming on many months after the patient has apparently recovered from all effects of the accident.

Symptoms.—When seen at an early stage the ophthalmoscopic signs are—

1. Change in the appearance of the optic disc, which is swollen and prominent, and oftentimes hazy from a semi-transparent whitish exudation over it. The degree of swelling of the disc is indicated by the abruptness of the bend of the retinal vessels as they pass over its margin on to the retina.

2. Blurring or loss of definite outline of the circumference of the disc, which may be either irregular, confused, or apparently lost, as if the margin of the disc merged into the surrounding retina.

3. Fulness of the retinal veins, which are large, dark-coloured, and sometimes tortuous, whilst the arteries may be normal in appearance, but generally appear small and even thready.

If the neuritis increases, the ophthalmoscopic signs are intensified, and portions of the vessels in their course over the papilla will often become obscured by a whitish, woolly-looking, inflammatory exudation. Occasionally there are small hæmorrhagic spots on the disc and in the adjacent retina, which in some cases is of a dull and whitish colour from inflammatory effusions, whilst the rest of the retina remains perfectly transparent. The appearance of a severe case of swelling of the optic disc is well shown in Fig. 165. There is usually a steady diminution of the acuity of vision, often accompanied with a contraction or partial loss of the visual field. The pupil is rather dilated and sluggish. The patient has no pain in the eye, nor are there any external manifestations to account for the increasing loss of sight.

When the neuritis is due to intra-cranial mischief, *both eyes* are almost invariably affected, and the disease is usually symmetrical; but one eye may be attacked a little in advance of the other, or the impairment of sight may be greater in one eye than in the other. After a variable time all the prominent ophthalmoscopic symptoms

of neuritis subside; the morbid effusions are absorbed, the disc becomes flattened and of a creamy white, and the arteries are reduced to mere threads; but for a long time the veins continue large and tortuous. With all these changes the sight diminishes until ultimately it is completely lost or reduced to a mere perception of large objects (**post-neuritic atrophy**).

Impairment of sight is by no means a constant symptom during the inflammatory stage. It frequently happens that patients with pronounced neuritis are unaware of any mischief in their eyes, and can read the smallest type without difficulty. On the other hand, cases sometimes occur, proceeding from intra-cranial causes, which are accompanied by great impairment of sight, but we do not know of any means by which these cases can be differentiated when first seen.

The **constitutional** symptoms associated with optic neuritis are headache, sometimes continuous, at others paroxysmal, and frequently accompanied by vomiting. In some cases the headache is intense, and it is this symptom which induces the surgeon to examine the state of the optic papilla. With the headache there may be giddiness, which may be occasional or almost constant; or there may be loss of smell, or defect of hearing, or occasional epileptic convulsions, or palsy of one or more of the ocular nerves, or a loss of the proper co-ordinating power over the muscles of the extremities.

Constitutional symptoms are not, however, present in every case, and gross organic disease of the brain may exist with bilateral optic neuritis as its only objective sign.

Differential Diagnosis and Prognosis.—It is difficult to form a prognosis in papillitis, and to attempt to do so it is necessary to group together all the symptoms and to estimate them as a whole.

Chronic headache and frequent vomiting with double neuritis point strongly to the presence of an intra-cranial tumour, and this supposition is increased if after a time there be other symptoms manifested, such as giddiness, tinnitus, deafness, or palsy of ocular nerves, or convulsions.

Acute head symptoms in young people with double optic neuritis suggest tubercular meningitis, and this diagnosis is strengthened if with the ophthalmoscope tubercles be found in the choroid.

Neuritis in one eye only, generally indicates pressure within the orbit, possibly some form of tumour or an aneurysm, or it may be pressure on the cavernous sinus from some growth within the skull, but not connected with the brain.

Neuritis in both eyes coming on some weeks after a severe head injury is very serious. It indicates some inflammatory action around the seat of brain injury, and such cases often terminate fatally. When neuritis comes on many months after a head injury, it may be due to cicatricial changes taking place at the seat of the brain injury; the patient usually recovers, but the sight is lost.

Neuritis arising from Bright's disease of the kidneys, or from constitutional causes, frequently cannot be diagnosed by the ophthalmoscope from neuritis due to intra-cranial disease. The association of constitutional and local symptoms with the neuritis is essential for a correct diagnosis.

Pathology.—For the pathology of neuritis due to intra-cranial disease *see* article on “Affections of the Eyes in Diseases of the Nervous System,” page 379.

Treatment.—This must be guided by existing symptoms. When there is great pain in the head, the subcutaneous injection of morphia, or of morphia with atropia, will often give great relief. If morphia alone cannot be borne, it may be tried in smaller doses combined with the bromide of potassium; or the bromide of potassium may be given during the day, and chloral at night. The medicine which seems to do the most good is iodide of potassium, which may be increased up to twenty grains three times a day, and to which may be added five or ten grains of the bromide. If there is reason to believe that the neuritis is due to a syphilitic gumma in the brain, in addition to the iodide of potassium, mercury should be given either in combination with the iodide, or in the form of the green iodide, or by inunction. When neuritis is due to a cerebral tumour, not syphilitic, appropriate medicines may relieve symptoms, but they will not cure the disease.

Victor Horsley* recommends trephining the skull in cases of neuritis from intra-cranial disease, even when there is no hope of permanent cure; as thereby the constant headache may be relieved, and the progress of the neuritis checked, so that the patient may retain some portion of his sight during the remainder of his life.

2. **NEURO-RETINITIS, OR ASCENDING NEURITIS.**—The inflammation is not limited to the optic nerve, but also includes the retina, from which it originates and extends to the optic nerve, ascending a short distance along its trunk.

Ætiology.—Most of the causes of neuro-retinitis have been discussed in “Diseases of the Retina.” The most frequent are syphilis and chronic kidney disease. It occasionally follows suppression of the uterine functions and over-lactation, and is a rare complication of fever, especially malaria and diphtheria.

Symptoms of Neuro-retinitis.—The optic disc is clouded, its outline is indistinct or lost, and the vessels as they pass over its surface are more or less obscured, but there is not the venous distension or the engorgement of the papilla which characterise the pure descending neuritis. The great point of distinction, however, between neuritis and neuro-retinitis is that in the one the retina is extensively involved, whilst in the other it is either not at all affected, or only for a short distance immediately surrounding the disc.

In neuro-retinitis the surface of the retina seems obscured by a diffused haze, which renders all the minute vessels indistinct, and gives a peculiar and characteristic washed-out appearance to the fundus. There is also an absence of the head symptoms which were noticed as being generally present in neuritis. In neuro-retinitis the disease is often confined to the one eye, whereas in the descending neuritis both eyes are generally affected.

The **prognosis** of neuro-retinitis, although unfavourable, is yet

* ‘Brit. Med. Journ.,’ 1893, ii, p. 1365.

more hopeful than that of descending neuritis, and especially if some blood-poisoning, such as syphilis, can be traced as the probable cause of the disease.

Treatment.—In *neuro-retinitis* care must be taken to ascertain the source of the disease, as it may be due to many causes, and the reader is referred to the special paragraphs in “Diseases of the Retina.” The only treatment that need be mentioned here is that required for neuro-retinitis dependent on or associated with great debility, such as that occurring after diphtheria or over-lactation, or in the course of malaria. In these cases the mineral acids, with cinchona, or some of the preparations of iron, are most likely to do good. A slight mercurial counter-irritation may be also kept up on the temple of the affected eye by rubbing in every night a little of the Ung. Hydrarg. Iodidi Rubri (F. 64), or by applying small blisters about the size of a shilling from time to time, and afterwards dressing the vesicated surfaces with simple mercurial ointment.

3. RETRO-BULBAR OR AXIAL NEURITIS.

This occurs in two forms: (1) **the acute**; (2) **the chronic**. The main feature about both forms is the partial nature of the inflammation, which is confined to the papillo-macular bundle of nerve-fibres. These fibres supply the area of central distinct vision (*see* “Anatomy”), and inflammation of these conducting paths consequently produces a central amblyopia, or dimness of vision, in the line of direct fixation.

General Symptoms.—Everything before the patient is veiled in a mist or fog, whilst to one side he may be conscious that the vision is clear. Central vision is lowered to a variable extent, being little more than light perception in some very acute cases, and vision is always better in a dull light. If we examine with the perimeter, we shall find the confines of the visual field of normal size, but as the fixation point is approached the test object begins to get misty, the indistinctness being greatest at the fixation point itself. Thus there is a central scotoma, the size and density of which are subject to considerable variations, and which usually assumes the shape of a horizontal oval, stretching outwards from the fixation point. In severe cases the scotoma round the fixation point may be absolute, so that the white test object cannot be perceived at all, and this absolute scotoma is bounded peripherally by an area in which, though white is visible, colours cannot be distinguished, *i.e.* there is a relative scotoma (*see* page 46). In less severe cases the scotoma is relative throughout, the white object being recognised, though mistily, at the fixation point itself. With the ophthalmoscope there is little to show for the severity of the subjective symptoms. There is generally some slight blurring of the edges of the disc, and as the case progresses there is generally a decided pallor of the temporal side of the papilla, where the affected fibres are located.

Pathology.—The researches of Nettleship, Samelsohn, Uhthoff, and others have shown that the inflammation is most marked at the

optic canal, where any inflammatory swelling is checked by the bony walls, and consequently undue pressure soon comes to be exercised on the conducting fibres. Why the papillo-macular fibres, which run near the centre of the nerve (axial fibres) and are consequently the least exposed to injury, should be those most affected there is at present no satisfactory explanation. Perhaps, as Gunn* has suggested, their high physiological differentiation renders them more prone to disorganisation, or it may be that even slight changes in these fibres are more readily appreciated.

I. ACUTE RETRO-BULBAR NEURITIS.—This occurs most commonly in women. It is characterised by its sudden onset, the rapidity and severity of the symptoms, its tendency to only affect one eye, and its liability to relapse.

Symptoms.—The general symptoms have already been enumerated. Vision in severe cases may be reduced to mere light perception or the counting of fingers at a distance of a few feet. The pupil is somewhat dilated, and does not react well to light. The patient generally complains of some pain on movements of the eye, and the globe is slightly tender to palpation through the lids, feeling as though it had been bruised. In this variety, symptoms generally advance very rapidly, so that the patient may be practically blind in the course of a few days.

The **prognosis** is usually favourable, and vision begins to return in the course of a week or two, or even sooner. The restoration of sight may be rapid, but is often slow, occupying many weeks or months, but eventually may be nearly or quite complete. On the other hand, the inflammation is sometimes followed by atrophy and permanent defect of sight. It is not uncommon for one or two relapses to occur just as the patient seems to be nearly well, so that the surgeon must be guarded in giving a prognosis as to the probable duration of the disease. If relapses occur, some permanent damage to sight must be expected.

Ætiology.—This is often indefinite. Syphilis, exposure to cold, rheumatism, gout, and influenza seem to predetermine the affection. It is possible that each of these affections may, in some instances, act by inducing a primary inflammation of the sphenoidal sinus which bounds the inner wall of the optic canal, and that the swelling in the sinus constricts the nerve in this situation, and sets up the congestive changes in the affected fibres. In some cases, however, the history throws no light on the cause. In one instance under our care the patient had recently recovered from a severe attack of exophthalmic goitre. In another the eye symptoms were preceded by a sense of numbness in both legs, though there was no actual loss of sensibility, and the tendon reflexes were normal. Very often the patients are of a highly neurotic temperament.

Treatment.—The eyes should be protected by spectrum-blue glasses, which cut off the irritating red rays. All close work should be strictly prohibited, and it is as well to enforce this by keeping the pupils under the influence of a mydriatic. A distinct history of syphilis, gout, or

* 'Trans. Ophth. Soc. U. K.,' xvii, p. 112.

rheumatism will indicate in such cases a special line of treatment ; but in doubtful cases we may fall back on strychnine, iodide of potassium, and mercury as the most useful drugs. In all cases counter-irritation by blisters to the temple, or inunction with the ung. hydrarg., is serviceable. Spectrum-blue protectors seem of great service, and should be worn constantly both in and out of doors.

2. CHRONIC RETRO-BULBAR NEURITIS.—Chronic retro-bulbar neuritis, unlike the acute form, always affects both eyes, and its onset is gradual and unaccompanied by pain on movement or by tenderness of the globe. The disease sometimes occurs in the course of disseminated sclerosis, but the vast majority of cases are due to a toxæmia induced by certain drugs, especially tobacco and alcohol. Many drugs are capable, when absorbed in poisonous doses, of producing toxic symptoms in the eye, and though not all manifest them by central amblyopia, it has been thought best, for the sake of convenience, to group them all together at this point under the heading of the "**Toxic Amblyopias.**" Only those drugs are mentioned which may be said to be of definite clinical importance.

1. **Tobacco-alcohol Toxæmia.**—These drugs form by far the largest class of the toxic amblyopias. Much dispute has arisen as to the independent power of either alone to produce ocular symptoms. Most observers agree in the power of tobacco to produce amblyopic symptoms without the aid of alcohol, but many have denied the converse. There can be no doubt, however, that although in the vast majority of cases the influence of tobacco cannot be excluded, yet occasionally typical symptoms arise in non-smokers who drink heavily. It is also equally clear that in a large number of cases the patients both smoke and drink alcohol in quantity, and it seems highly probable that toxic effects are induced more quickly and readily when both drugs are acting in concert.

Tobacco-alcohol amblyopia is chiefly confined to the poorer classes. It is, as would be supposed, far commoner in men than in women, and rarely if ever occurs before forty years of age, and after many years' indulgence in the drug or drugs. It almost exclusively occurs in smokers of cheap, highly flavoured tobaccos, such as cheap shag and twist. It is also most generally seen in men who have been for some time out of work, or from some cause have been exposed to privations and exposure, and whose vitality is consequently at a low ebb. These facts sufficiently explain the rarity of toxic symptoms in people of the richer classes.

Symptoms.—These consist of a lowering of central vision which cannot be improved by glasses, and presenting all the characteristics of central amblyopia already described (page 366).

The diagnosis is made by the history and by attention to the special clinical features. It may generally be suspected when there is marked lowering of visual acuity without the presence of any corresponding gross lesion.

The prognosis is usually very favourable if the drugs are given up.

Undoubtedly total abstinence from both alcohol and tobacco is the best course, and should be strongly urged. Complete recovery is then frequent, sometimes in the course of a few weeks in the most favourable cases. There remain, however, a certain number in which the prognosis is not so good, *viz.* cases in which there is marked general contraction of the visual field and defects in the general colour-sense, symptoms indicative of permanent atrophic changes in the nerve. Restoration of sight in such cases can only be partial at the best, and a few tend to get slowly worse in spite of all treatment, though it is very rare for any case to run on to absolute blindness.

The treatment, in addition to abstinence from the drug, lies in improving the general health by good food and warm clothing, both of which are often much needed by these patients, and by the administration of nerve tonics, especially strychnine and arsenic. Hypodermic injections of pilocarpine and the slowly interrupted constant current—one pole applied over the eye and the other to the neck or elsewhere—have been recommended. As regards the latter, it is to be remembered that the number of cells that should be employed is represented by the fewest required to produce the sensation of sparks or flashes of light. The current should be employed daily for several weeks, but each sitting should not last longer than ten minutes.

2. Lead Toxæmia.—On account of the precautions now exercised in lead factories, cases of toxæmia are much rarer than formerly. Ocular symptoms are generally a late manifestation of lead poisoning, when the kidneys have become affected, and albuminuria is present. The effects of lead poisoning are seen in many phases in the eyes. Double optic neuritis with typical ophthalmoscopic signs may occur, and this may clear up or develop into subsequent atrophy of the nerve with shrunken vessels and generally contracted field; or sometimes a primary optic atrophy is seen without the signs of any previous inflammation. Cases of central amblyopia such as is seen in tobacco-alcohol poisoning have been described, as well as a few instances of simple transitory amblyopia and of paralysis of the external muscles analogous to wrist-drop.

The diagnosis is made by the signs of lead poisoning elsewhere. The typical blue line on the gums should be sought, and inquiries made as to colic and the presence of wrist-drop, etc.

The prognosis, as regards the eyes, must necessarily depend much upon the general health of the patient. If kidney mischief or cerebral symptoms are present, the prognosis must be regarded as grave, and treatment is not likely to be attended with great success. *Cæteris paribus*, the cases in which the signs are those of central amblyopia, and not of a general atrophy of the nerve, are the most hopeful. In the former case the peripheral field of vision will not be contracted.

Treatment.—Removal from all contact with the metal. Iodide of potassium is generally regarded as the most useful drug, and strychnia by mouth or by hypodermic injections may be tried. The slowly interrupted constant current should be given a trial in atrophic cases. Prophylactic measures need not be discussed here.

3. Quinine Toxæmia.—The researches of De Schweinitz* have contributed greatly to our knowledge of the toxic influence of this drug. Ocular symptoms from quinine poisoning are very rare, though a fair number of cases are on record, and as a rule very large doses are required. The symptoms are those of sudden and complete blindness, accompanied by excessive "tinnitus aurium" and deafness. The ophthalmoscopic picture is that of extreme pallor of the disc, accompanied by excessive contraction of all the retinal vessels. The latter, De Schweinitz has shown to be due to vaso-motor constriction induced by highly cinchonised blood; and Holden† has recently proved experimentally that the amblyopic symptoms arise from a degeneration of the nerve-fibre and ganglionic cells of the retina, due to insufficient nourishment on account of the arterial constriction. Casey Wood‡ has found that all salts of quinine may produce toxic symptoms, and, if their use is then prolonged, definite atrophy of the optic nerves follows.

The diagnosis is made from the history and other signs of quinine poisoning, tinnitus aurium, and deafness.

The prognosis is usually very favourable. Absolute blindness may persist for some days, but complete recovery often follows, and useful sight is always regained. Patients who have once experienced toxic symptoms remain very susceptible to the drug.

The treatment chiefly consists, as in all forms of toxic amblyopia, in the immediate cessation of the use of the drug, with the addition of tonics, such as cod-liver oil, combined with hypodermic injections of strychnine and the constant current.

4. Carbon-bisulphide Toxæmia.—Several cases of toxæmia from this drug have been recorded, and a committee of the Ophthalmological Society issued a special report on the subject in 1885, and tabulated twenty-four cases. The drug is used in the "curing" or "vulcanising" room of rubber factories. Its poisonous effects are manifested by long exposure to its fumes and not by contact with the skin. It attacks workmen of all ages. In a certain number of cases the patients have been smokers. The ocular symptoms may be those of a central amblyopia such as occurs in tobacco poisoning, or the nerves may be generally involved in a partial atrophy with peripherally contracted fields. Ophthalmoscopically the changes consist of pallor of the discs with slight haziness of their margins. General toxic effects always accompany the ocular symptoms, and are shown by great muscular and mental depression; the former especially characterised by weakness of the legs, and the latter by vertigo and loss of memory. Loss of sexual desire is also a common symptom.

The prognosis is very fair if the patient is removed from contact with the fumes. Complete recovery follows in some cases, but only partial restoration is seen in others. General contraction of the fields is an unfavourable sign. Relapse will follow if the patient returns to his former employment.

* 'The Toxic Amblyopias,' 1896.

† 'Trans. Am. Ophth. Soc.,' 1898.

‡ "The Toxic Amblyopias," 'Annals of Ophth. and Obst.,' pp. 92—94.

The treatment consists in the exhibition of tonics, strychnine, etc. Phosphorus in small doses has been recommended, as also the constant current; but the most important point is the removal of the patient from the source of his trouble.

5. Iodoform Toxæmia.—This is very rare, but a few cases of central amblyopia with central colour scotoma have been recorded. Priestley Smith* has published an example where toxic symptoms followed the ingestion of 1000 grains of iodoform in forty-one days, and Critchett† another instance in which iodoform had for a long period been applied very liberally to a large ulcerated surface. In each instance improvement slowly followed the cessation of the drug.

6. Cannabis-indica Toxæmia.—The evidence of amblyopic effects produced by this drug rests chiefly upon the authority of Ali,‡ who encountered many cases in Persia. Casey Wood states that he has been unable to find a single case in America or Europe; but this is accounted for by the fact that "haschisch" smoking is a vice almost confined to Orientals.

According to Ali, symptoms of a "central amblyopia" such as is seen in cases of tobacco poisoning are quite common. Other less important ocular symptoms have been described by a few authors.

The treatment would mainly consist, as in all forms of toxic amblyopia, in the removal of the patient from the influence of the drug.

7. Salicylate-of-soda Toxæmia.—A case of absolute temporary blindness after large doses of this drug has been recorded by Gatti.§ Vision was completely restored. The ocular symptoms were accompanied by deafness. No special treatment beyond the immediate cessation of the drug was adopted. Other observers have noticed temporary amblyopia from the continued use of this drug in large doses.

8. Di-nitrobenzol and Nitrobenzol Toxæmia.—Di-nitrobenzol is used in the manufacture of explosives, such as roburite, and the dust given off in the processes of grinding and mixing the material are very poisonous. Snell|| has drawn attention to the ocular symptoms that may be developed in cases of poisoning by this drug, and has recorded five cases. He describes the symptoms as consisting in diminution of central vision, concentric contraction of the visual fields, with in many cases a central colour scotoma, engorgement of the retinal veins, and some pallor of the disc with a varying amount of blurring of its outline. Nitrobenzol, which is closely allied to di-nitrobenzol, and is used in making aniline dyes, may produce toxic symptoms of a similar nature. Recovery tends to follow removal of the patient from his work.

* 'Ophth. Rev.', 1893, p. 101.

† 'Trans. Ophth. Soc. U. K.', xviii, p. 383.

‡ "Des Amblyopies toxiques," 'Recueil d'Ophth.', 1876, p. 258.

§ 'Gazz. degli Osp.', 1880, i, 4.

|| 'Brit. Med. Journ.', 1894, vol. i, p. 449.

OPTIC ATROPHY.

There are two main varieties of optic atrophy :

1. **Atrophy proceeding from intra-cranial disease.**
2. **Atrophy proceeding from extra-cranial disease.**

1. **ATROPHY FROM INTRA-CRANIAL DISEASE.**—**Cerebral.**—The disease is almost always bilateral, and almost always secondary to optic neuritis (*post-neuritic atrophy*).

Cerebro-spinal.—Primary bilateral atrophy occurs frequently in tabes dorsalis, and more rarely in lateral sclerosis and general paralysis of the insane.

Senile Atrophy.—Atrophy sometimes occurs in old people without any cerebral or spinal symptoms, and analogous to a similar condition of the auditory nerve and deafness. Usually both eyes are affected, though the condition may be unsymmetrical. It is unaccompanied by any inflammatory symptoms, and progresses slowly to absolute blindness.

2. **ATROPHY FROM EXTRA-CRANIAL DISEASE.**—The causes are numerous, and may be grouped as **extra-ocular** and **intra-ocular**. In many cases the atrophy is secondary to optic neuritis, and, in contradistinction to the atrophy due to intra-cranial disease, it is frequently confined to one eye.

a. **Extra-ocular Causes.**—*Injury.*—The optic nerve may be cut or lacerated by penetrating wounds of the orbit, by stabs, bullet wounds, etc.; or the injury may be indirect and caused by the pressure of extravasated blood, orbital tumours, or exudations; or the nerve may be constricted in the optic canal by a spicule of bone from fracture of the anterior fossa of the skull, or by a tumour involving the sphenoidal sinus.

Embolism of the Central Artery.—Here the succeeding atrophy is simply a necrotic process resulting from the cutting off of the blood-supply.

Atrophy from Acute Anæmia.—Profuse and rapid loss of blood is sometimes followed by a rapid and permanent loss of vision from optic atrophy. We have known such a case of permanent blindness follow extensive flooding after parturition; but in most recorded cases the hæmorrhage has occurred from the gastro-intestinal tract. Holden* has found by direct experiments on animals that the hæmorrhage is first followed by œdema of the nerve-fibre and ganglion layers of the retina, which is followed in a few days by definite degenerative changes in the ganglion cells themselves.

Toxic Atrophy.—The continuous and prolonged absorption of many drugs in large doses may ultimately lead to a bilateral atrophy, preceded in many cases by a retro-bulbar neuritis (see "Toxic Amblyopias").

b. **Intra-ocular Causes.**—*Affections of the choroid and retina* may secondarily spread to the papilla, such as syphilitic chorio-retinitis and retinitis pigmentosa.

Increased Intra-ocular Pressure.—Glaucoma, both primary and secondary to diseases of the iris, lens, etc., or caused by excessive intra-ocular hæmorrhage, is a frequent cause of atrophy.

Panophthalmitis.—The nerve is at first secondarily inflamed, and

* 'Arch. of Ophth.,' xxviii, pt. 2, p. 125.

ultimately shares in the shrinking and wasting that follow the subsidence of the inflammation.

Symptoms of Optic Atrophy.—An increasing dulness of sight, both for near and distant objects, which is not improved by glasses, excepting those which act as powerful magnifiers, when small objects, from being rendered larger, are better seen; and contraction or partial loss of the field of vision. The contraction may be regular in all directions or more marked in one segment than another. The colour-sense is affected early, and this becomes very marked as the disease progresses. Red and green are the colours first lost; but ultimately there is frequently complete colour-blindness, and everything appears as white-grey or black. In rare cases, although really colour-blind, the patient sees everything through a coloured veil tinged with green or violet, and this sensation is described as peculiarly vivid. When the atrophy is due



FIG. 172.—Primary or “white” atrophy of the optic nerve. The bending of the vessels as they pass over the disc indicates the presence of an atrophic cup.

to affections of the spinal cord the pupils are contracted (spinal myosis), and frequently exhibit the Argyll-Robertson phenomenon (*see also* page 387), being inactive to light stimuli, but reacting sluggishly to accommodation. In atrophy due to other causes, especially cerebral disease, the pupils are rather dilated and sluggish in the early stages; whilst later they become widely expanded and fixed, giving to the eyes the peculiar vacant stare which is so characteristic of blindness from cerebral disease.

Ophthalmoscopic Appearances.—These vary to a certain extent with the cause. The disc is always strikingly anæmic, this pallor varying from a translucent pearly or bluish-white hue to a dense chalky whiteness, seen in its most pronounced form in atrophy from intracranial disease. This appearance of the disc in atrophy from intracranial disease has caused the term “*white atrophy*” to be applied to it. Generally speaking, the disc is of a pearly, tendinous whiteness, and the small vessels which are usually seen on its surface, and to which its normal pink colour in health is due, are shrunk from view.

In **primary atrophy**, *i.e.* atrophy that has not been preceded by inflammation, the edges stand out with unusual sharpness, and are frequently notched and irregular, whilst a large choroidal ring is often present. In some cases the nerve-head is sufficiently translucent to allow the lamina cribrosa to be seen as a dark mottling, whilst in advanced cases there is frequently a shallow excavation of the disc, known as the "**atrophic cup**." This consists in a gradual shelving from the margin towards the centre, due to shrinking and falling in of the central portions of the papilla. It causes but little displacement of the vessels—quite different from the steep excavation in glaucoma (*see* Figs. 38 and 120).

When, however, the atrophy follows inflammation (**secondary or post-neuritic atrophy**), the outline of the disc rarely regains its previous clearness, but remains cloudy and ill-defined. Atrophic cupping is not seen in this variety; on the contrary, the ordinary physiological



FIG. 173.—Post-neuritic or secondary atrophy of the optic nerve. The disc outline is indistinct, and the vessels thread-like. The usual physiological cup is obliterated, and the disc looks flat. Compare with Figs. 37 and 172.

excavation is filled in by organised exudation, so that the lamina cribrosa cannot be distinguished, and the papilla is markedly flat.

The retinal vessels are subject to considerable variation as to size. When the atrophy follows neuritis, they are usually much withered from the shrinking of the exudates, and in the later stages of atrophy from any cause they are apt to be much reduced in size, partly no doubt from the diminution in the functional activity of the retina. In some cases, however, especially in atrophy of a primary nature, there is for a long time very little alteration from the normal in the calibre of the vessels, whilst in others, evidence of slight pressure may exist in the presence of distended veins but unaltered arteries.

Diagnosis.—The failure of sight, condition of fields, and ophthalmoscopic evidence will make the case clear, but it is necessary to warn against trusting to the ophthalmoscopic picture alone. The colour of

the optic disc is very fallacious, and in anæmic or old patients there may be very considerable pallor with a perfectly healthy nerve.

Prognosis.—This is always very unfavourable as regards cure, but as regards arrest of the disease short of blindness a good deal depends upon the cause. The most favourable cases are those in which the atrophy depends upon some form of intra-ocular disease, such as glaucoma or syphilitic retinitis, which are amenable to treatment; or to some pressure in the orbit, such as a cyst which can be removed without enucleation of the globe. The condition of the retinal vessels is also an important point, much contraction being a bad sign. Atrophy from spinal disease and senile atrophy are always progressive, and the prognosis is therefore most unfavourable.

Treatment.—As indicated in speaking of the prognosis, the first endeavour must be to assign the cause, and then to treat that by appropriate remedies.

For the white atrophy of the optic nerve which proceeds from cerebral disease, the subcutaneous injection of strychnine has been recommended in doses commencing at gr. $\frac{1}{60}$ and increased daily by gr. $\frac{1}{60}$ until the quantity injected reaches gr. $\frac{1}{20}$. It is very doubtful whether this treatment does any good, and it is certainly not free from danger. We know of one case in which violent convulsions followed the injection of $\frac{1}{30}$ of a grain of strychnia, although the patient had previously on several occasions, at intervals of two or three days, had the same dose administered. Mercury and the iodides are indicated when there is reason to suspect a syphilitic taint, and nitro-glycerine in doses of gr. $\frac{1}{100}$ may be tried with a view of increasing functional activity.

In some cases the use of the constant electric current seems to do good. The sponges having been moistened with salt and water, one is to be placed over the closed eyelids of one eye, and the other sponge either at the nape of the neck, or at the back of the ear over the mastoid region, or on the forehead over the supra-orbital nerve, according to the selection of the patient. The point selected is the one which most readily yields flashes or balls of light with the fewest cells. At first only from three to five cells should be used, but these may be increased to sixteen or eighteen if they can be borne without inconvenience. The position of the positive and negative poles may be changed two or three times during each sitting, which should not last longer than from ten to fifteen minutes daily.

Other forms of treatment proposed and tried have been a course of sweating by hypodermic injections of pilocarpine or by Turkish baths, whilst some surgeons advise a diet made up as much as possible of the hydrocarbons. Phosphorus has been very generally recommended, but it is a dangerous remedy, and it is more than doubtful if it has ever done any good.

TUMOURS OF THE OPTIC NERVE.

These are very rare, and are divisible into two classes, both of which, however, present the same clinical symptoms.

1. Tumours of the optic nerve-sheath.

2. Tumours of the optic nerve proper.

The first variety is by far the more common. The tumours are usually sarcomatous, and very frequently exhibit myxomatous changes. Pure myxomata are sometimes found, and more rarely fibromata or myxo-fibromata. They may arise in connection with either the dural or pial sheath, and form rounded tumours embracing the nerve, which passes through unaltered except from pressure. In the second variety the nerve-fibres are expanded and separated by the growth, which takes its origin in the interstitial tissue of the nerve, and usually exhibits the microscopical features of glioma.



FIG. 174.—Myxo-fibroma of the optic nerve-sheath. (From a case of a child æt. 2 years.)

The myxomatous changes, so frequent in cases of the first variety, may possibly be due to their being involution tumours of the vitreous, a fragment of which has become cut off during the closure of the choroidal fissure.

Tumours of the optic nerve are found at all ages, but occur with the greatest frequency in young subjects between the ages of two and ten years. They are frequently of slow growth, and usually cause no pain until of considerable size.

Symptoms.—The symptoms which suggest tumour of the optic nerve are—*a.* Proptosis of the eye directly forwards, with little or no limitation of movement.

b. A rapid loss of sight preceding or accompanying the proptosis.

c. White atrophy of the nerve, due to pressure upon its fibres by the growth.

Differential Diagnosis between Tumour of the Optic Nerve and other Orbital Tumours.—When failing sight going on to blindness and white atrophy of the nerve *precedes* proptosis in a directly forward direction, the diagnosis is strongly in favour of a tumour of the optic nerve; but when the defective sight *follows* proptosis, and when the eye is displaced obliquely, the diagnosis is orbital tumour.

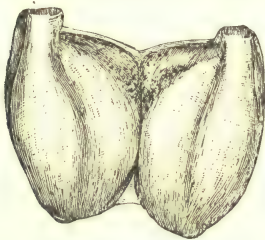


FIG. 175.—Fibroma of the optic nerve.

Prognosis.—This is fairly good, especially in tumours of the first variety, if taken early enough before the growth has extended back through the optic foramen.

Treatment.—Free removal of the growth and surrounding soft parts, or, in other words, complete extirpation of the orbital contents.

If doubt arises as to the nature of the growth, an exploratory incision through the lid and a preliminary examination of the orbit with the finger should be made. A good many deaths after operation from septic meningitis have been recorded. It is therefore imperative to use every aseptic precaution. The chief danger lies in the accumulation of lymph

and blood-clot at the bottom of the wound, and care should be therefore taken to keep the cavity dry for some days by firmly plugging it with tampons of some aseptic material, such as the bichloride gauze.

For the method of performing exenteration of the orbit see "Diseases of Orbit."

HYALINE BODIES ON THE PAPILLA (*Drusenbildungen*).—This is a rare condition, in which the optic papilla is studded with little translucent nodules or verrucosities. The ætiology and pathology of these bodies are not at present understood; but with the ophthalmoscope the surface of the disc appears swollen and indistinct, and careful focussing reveals that this is not due to inflammatory effusion, but to the presence of these curious opalescent nodules. The bodies may be distributed all over the disc surface, or may be chiefly aggregated round its edge or about its centre, and occasionally they have been noticed to invade the retina in the immediate neighbourhood.

The bodies cause no impairment of vision, and the affected eyes are often quite healthy in other respects; but, on the other hand, retinitis pigmentosa has been present in several recorded cases. Both eyes are commonly affected, though not necessarily to the same extent.

INJURIES OF THE OPTIC NERVE.

The optic nerve may be wounded behind the eye by the passage of foreign bodies into the orbit, by stabs, or shot, or bullet wounds, or by a fracture of the skull involving the orbit.

Symptoms.—Sudden loss of sight, the loss being appreciated by the patient immediately on receiving the wound. More or less dilatation of the pupil, which is uninfluenced by light, and no apparent injury to the eye to account for the sudden deprivation of sight. Examined with the ophthalmoscope, there is at first no appreciable change in the appearance of the optic disc, except perhaps it may appear slightly more pink than the nerve in the other eye; but this increased vascularity is very soon followed by pallor, and ultimately the disc becomes quite white, with the arteries small, and presents all the usual appearances of primary atrophy.

Treatment.—No applications nor medicines will restore the wounded optic nerve. The sight which is lost is irreparably gone; but attention must be directed to the wound, and if a foreign body be detected in the orbit, it should be removed (*see article "Foreign Bodies in the Orbit"*).

CHAPTER XXIII.

AFFECTIONS OF THE EYES IN DISEASES OF THE NERVOUS SYSTEM.

OCULAR symptoms are often of special significance in diseases of the nervous system. If rightly appreciated and grouped together, they may prove of the highest importance in the diagnosis and localisation of disease, whereas without this knowledge they frequently form a hopeless tangle of isolated symptoms. We have thought it best, therefore, to devote a short chapter to this subject, describing first the symptoms that follow upon lesions involving the optic, sensory, and motor nerve-paths of the eye, and concluding with a short summary of the ocular symptoms exhibited in those varieties of nerve disease in which the eye is commonly affected, or in which the ocular symptoms form an aid to diagnosis.

I. THE OPTIC PATHS.

ANATOMY.—The cortical centre for vision is situated in the occipital lobe. The exact site is somewhat speculative, but weight of evidence is in favour of its being placed on the mesial aspect of the occipital lobe in the neighbourhood of the calcarine fissure. There is also evidence of the angular gyrus being concerned in vision, and lesions of this convolution are especially concerned in the form of aphasia known as “word-blindness.” From the visual centre, fibres known as the optic radiations pass through the most posterior part of the internal capsule to the pulvinar of the optic thalamus, the external geniculate body and the superior corpus quadrigeminum or testis of the same side, being also reinforced in this situation by fibres from the internal geniculate body. The latter are known as the internal root, whilst the fibres from the other ganglia form the chief or external root, the two roots joining together to form the **optic tract**. Each tract winds round the crus cerebri, and as it does so, special connecting fibres pass through the

crus to the pupillary centre in the oculo-motor nucleus, thus establishing a path for the pupillary light-reflex. Thence, passing forwards and inwards along the base of the brain, the two tracts gradually approach each other, and on the optic groove on the sphenoid coalesce and partially decussate with each other, forming the **optic chiasma**.

The chiasma contains three well-marked sets of fibres.

I. Non-decussating fibres.

—These are derived from the external portion of each tract, and pass to supply the outer half of the retina of the same side.

2. Decussating fibres.

These form the largest portion of the tract, and are derived from rather more than the inner half of the tract. They pass across to supply the inner half of the retina of the opposite side.

3. Commissural fibres, which occupy the most posterior portion of the chiasma, and consist of fibres which pass across from one tract to the other. They have probably nothing to do with vision, and contain the fibres derived from the internal geniculate bodies.

From the anterior portion of the chiasma spring the two optic nerves, each nerve thus consisting of fibres derived from both optic tracts; those from the tract of its own side supplying the temporal half, and those from the opposite tract supplying the nasal half of the retina.

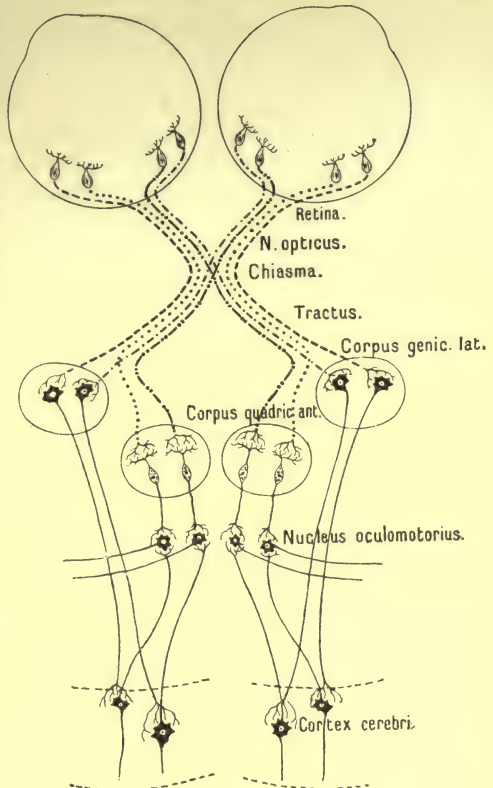


FIG. 176.—Diagram to illustrate the origins and course of the optic fibres. (Modified from Schäfer.)

2. SYMPTOMS DUE TO LESIONS INVOLVING THE OPTIC PATHS.

OPTIC NEURITIS.—This is a frequent and classical symptom of cerebral tumour. When due to this cause it, with very rare exceptions, affects both eyes, and ultimately, unless relieved by the operation of trephining (*see* page 365), passes into optic atrophy and complete blindness. Unfortunately it has little value as a localising sign, for it may arise during the growth of a tumour situated in any part of the cerebrum or cerebellum. Speaking generally, it is to be regarded simply as

an external sign of an increased intra-cranial pressure, and as the tendency of a new growth to heighten the pressure within the cranium must depend upon its situation as well as upon its size, the severity of the neuritis forms no gauge as to the actual size of the tumour; and, moreover, the extreme length of the optic tracts renders them liable to direct pressure from tumours with widely separated origins. The extent of our present knowledge of the value of optic neuritis as a localising sign of intra-cranial growth is thus summed up by Marcus Gunn:—“At present I do not think we are justified in saying more than (1) that intense double optic neuritis with much swelling and surrounding retinal change coming on quickly suggests the cerebellum; (2) that one-sided optic neuritis or marked difference suggests the cerebrum, and is on the whole in favour of the tumour being on the same side as the excess of neuritis, where there are other reasons for localising one in the front of the cerebrum.”

The immediate cause of the neuritis is most probably some interference with the circulation of the cerebro-spinal fluid, brought about by the increase in intra-cranial pressure. Bearing in mind the continuity existing between the optic nerve-sheaths and the great subarachnoid space (*see* “Anatomy of Optic Nerve,” page 361), it is evident that a tumour which interferes with the cerebro-spinal circulation will as a consequence cause a general dropsy or engorgement of the subarachnoid space in which the optic sheaths will share. The pressure exercised by this dropsical condition will induce congestion and inflammation of the nerve-tissue, which will be increased still more by the constriction of the unyielding bony walls of the optic canal. This theory serves to explain the frequent affection of other cranial nerves, and the reason why deafness, tinnitus, perversion and loss of smell, facial neuralgia, etc., are of frequent occurrence in cerebral tumours. It must be added, however, that this “engorgement” theory is not universally accepted, and some writers hold that the neuritis is due to an extension of an inflammation at the seat of disease, which is propagated to the papilla either through a direct continuity of nerve-tissue, or by an inflammation through the connective-tissue structures and blood-vessels of the optic nerve.

Optic neuritis also occurs as a symptom of meningitis, especially basal meningitis of tubercular origin; and it may also occur more rarely as a complication of a general cerebro-spinal disease.

For the clinical signs and treatment of optic neuritis *see* page 363.

OPTIC ATROPHY.—Atrophy following neuritis (post-neuritic atrophy) has already been mentioned as the common sequel to inflammation. Primary optic atrophy may be a *very rare* complication of a cerebral tumour, but it not infrequently follows as a result of destructive lesions of the brain, such as hæmorrhage or the contusions and lacerations which follow penetrating wounds and fractures of the skull. It may also occur as a symptom of diffuse or general nerve disease, especially in tabes, disseminated sclerosis, and general paralysis of the insane. When optic atrophy arises from any of these causes it is almost always bilateral.

For the clinical signs and treatment of optic atrophy *see* page 373.

* ‘Brain,’ 1898, Autumn, p. 337.

VASCULAR CHANGES IN THE RETINA.—Williamson* has drawn attention to this point, and remarks that in certain severe cases of cerebral hæmorrhage, embolism, and thrombosis, retinal hæmorrhages or dilatation of the retinal vessels may be noted in the eye of the same side as the brain lesion; whilst the opposite retina has not presented either of these changes.

HEMIOPIA.—Lesions involving the occipital lobe, optic tract, and optic commissure are especially characterised by blindness of one half of each visual field, a condition known as "*hemioopia*" or "*hemianopsia*."

Hemioopia may be (*a*) **altitudinal** or (*b*) **vertical**.

(*a*) **Altitudinal Hemioopia**, or loss of the upper or lower halves of the visual fields, is very rare. It is difficult to understand such a lesion except as the result of injury to the cortical visual centres. Critchett† and Fisher‡ have both recently published instances of loss of the lower halves of the visual fields which occurred as the result of bullet wounds involving the occipital lobes of the cerebrum.

(*b*) **Vertical Hemioopia** may be of three kinds:—(1) The most frequent variety is **homonymous hemioopia**, due to paralysis affecting the whole of one optic tract, and so termed because the corresponding halves of the two retinae, *viz.* the outer half of one and the inner half of the

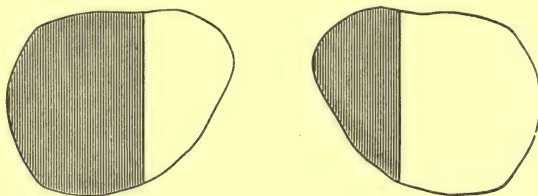


FIG. 177.—Left homonymous hemioopia. The shaded area represents the blind portion of the field.

other, are blinded. Remembering that each optic tract supplies the outer half of the retina of the *same* side, it will be seen that paralysis of the right optic tract will blind the right halves of the two retinae, and as the defect in the visual field is always on the opposite side to the retinal lesion, it follows that paralysis of the *right* tract will produce blindness on the left side of each visual field, and the patient will see nothing to the left of the mesial line; that is, he will have *left* homonymous hemioopia (see Fig. 177).

2. **Bi-temporal Hemioopia.**—This implies a lesion involving blindness of the outer half of each visual field, and consequently of the inner half of each retina (Fig. 178), a condition that can only be brought about by a lesion cutting off the decussating or internal fibres of each optic tract, and which must therefore be situated either in the commissure itself or in the median line just behind it. A patient with bi-temporal hemioopia can see things in front of him quite clearly, but the scope of his visual

* 'Brit. Med. Journ.,' 1898, vol. i, p. 1515.

† 'Trans. Ophth. Soc. U. K.,' vol. xxi, p. 123.

‡ Idem, p. 132.

field is much reduced, and it is possible that some cases have thus passed unrecognised or diagnosed as contracted fields. Bi-temporal hemiopia has been frequently observed in acromegaly.

3. **Bi-nasal Hemiopia.**—This is the rarest of the three forms, and implies the paralysis of the external or non-decussating fibres of each tract which supply the outer halves of the two retinae; and consequently their paralysis will cause blindness in the nasal half of each visual field. This paralysis is very curious and difficult to understand; but though excessively rare its occasional existence has been well authenticated,

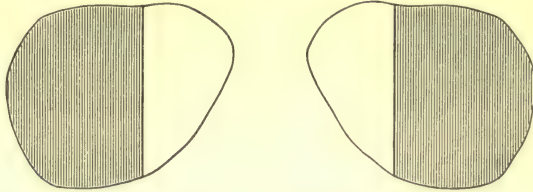


FIG. 178.—Bi-temporal hemiopia. The shaded area represents the blind portion of the field.

notably in a case recorded by Knapp in which there was atheromatous degeneration of the circle of Willis and pressure on each side of the chiasma by an atheromatous posterior communicating artery; and in a case recently published by Burnett* in which the hemiopia followed a fall on the forehead. This patient died, but unfortunately a post-mortem examination was not obtained. Lang and Beevor† have also recorded a case of bi-nasal hemiopia occurring in tabes dorsalis.

In all forms of hemiopia the line dividing the blind from the perceptive portion of each retina is sharply defined, and usually the fixation

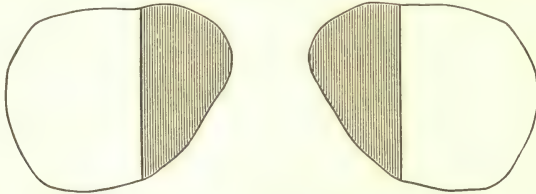


FIG. 179.—Bi-nasal hemiopia. The shaded area represents the blind portion of the field.

point partly or wholly escapes, the line passing vertically through it or on a slightly lateral plane.

In a few cases the vision is only lost over a corresponding sector or quadrant of each field, or the hemiopia is not absolute, and the perception of light is retained over a portion or the whole of the affected area, whilst it has still more rarely happened that the hemiopia has involved the colour-sense only.

As regards the localisation of the lesion in the various forms of hemiopia, it can only be said to be fairly definitely settled in the case of bi-temporal hemiopia, when, as above stated, it is probably situated in

* 'Arch. of Ophth.,' vol. xxix, pt. 1, p. 1.

† 'Trans. Ophth. Soc. U. K.,' vol. xiv, p. 247.

the chiasma or the median line just behind it. We know so little of bi-nasal hemiopia, and it is so difficult to understand the nature of a lesion that can produce this paralysis according to our present knowledge of the distribution of the optic fibres at the chiasma, that dogmatic assertion is impossible. In homonymous hemiopia similar clinical symptoms result at whatever part of its course the tract is injured; but collateral signs sometimes exist which may materially aid the diagnosis of the site. Thus, if the lesion be in the cortex, there may be other special signs of cortical irritation, such as the various forms of aphasia or "psychical blindness;" or the hemiopia may be associated with hemiplegia, in which case the internal capsule may be the seat of injury. If the lesion is basal, there may be an associated paralysis of one or more of the ocular nerves, and as a further indication Wernicke has described a phenomenon of the pupil which may be observed in some cases of hemiopia of basal origin, and which is known as the "**hemiopic pupillary reaction.**" It consists in this—that if a light is thrown into the eye so as to be entirely concentrated upon the blind portion of the retina, the pupil will react sluggishly or not at all, whereas if the cone of light impinges on the sensitive half of the retina a normal reflex contraction at once follows. This indicates that the lesion is situated somewhere anterior to the junction of the connecting fibres running between the optic tract and the nucleus of the third nerve (see "Anatomy," page 379).

3. THE MOTOR AND SENSORY PATHS.

ANATOMY.—**The third nerve** arises in the floor of the aqueduct of Sylvius close to the middle line, being only separated from the opposite third-nerve origin by the median raphe. It consists of a series of nuclei which besides giving origin to the fibres that innervate the levator palpebræ, superior, inferior, and internal recti, and inferior oblique, contain also ganglion cells that form at least three special centres situated in the following order from before backwards:—(1) A centre for the contraction of the pupil; (2) a centre for accommodation; (3) a centre for the associated action of the internal recti for convergence. The three centres are close to each other, and are all ordinarily excited by the same stimulus. In addition, fibres pass from the pupil-contracting centre to the optic tract of the same side, as mentioned in the anatomy of the optic paths. From these nuclei of origin the oculo-motor fibres traverse the crus cerebri, and, emerging on its inner side as the third nerve proper, pass thence along the base of the brain and outer wall of the cavernous sinus to the sphenoidal fissure, where they enter the orbit.

The fourth nerve arises from nuclei placed just posterior to the origin of the third nerve and beneath the nates. Inclining inwards it emerges at the valve of Vieussens, in which it decussates with the nerve of the opposite side, and curling round the crus cerebri passes along the base of the brain to the outer wall of the cavernous sinus lying external to the third nerve. Thence it passes into the orbit through the sphenoidal fissure.

The ophthalmic division of the fifth nerve arises with the rest of the sensory portion of the nerve from an extensive origin in the upper part of the floor of the fourth ventricle. From its origin the fifth nerve passes through the pons, and thence reaches the upper border of the petrous bone, where the Gasserian ganglion is formed and the ophthalmic nerve proper given off. The nerve runs along the outer wall of the cavernous sinus to the sphenoidal fissure, entering the orbit in three divisions, the lacrymal, frontal, and nasal nerves, of which the last-named carries all the fibres destined for the nutrition and sensation of the globe, which it distributes by means of the long ciliary nerves and a branch to the lenticular ganglion; whilst the lacrymal nerve supplies the lacrymal gland, and the frontal nerve the skin of the forehead and side of the nose.

The sixth nerve nucleus is situated on the floor of the fourth ventricle, close to the median line, and adjacent to the origin of the facial nerve, the fibres of which curl round the sixth nucleus, and are therefore not infrequently involved in lesions affecting it. The fibres pass through the pons, and emerge at its lower border. Thence the nerve passes along the base of the brain to the cavernous sinus, where it lies close to the internal carotid artery on its outer side, between it and the venous sinus,—an important point, as its situation renders it more liable to injurious pressure in a cavernous arterio-venous aneurysm than any other of the ocular nerves. The sixth nerve is also specially liable to be injured in fractures of the middle fossa of the base of the skull, as it passes in close proximity to the apex of the petrous portion of the temporal bone. In consequence of its slender size and long intracranial course, this nerve is also the one most frequently affected in cases of increased intra-cranial pressure due to tumours.

4. SYMPTOMS DUE TO LESIONS OF THE MOTOR AND SENSORY PATHS.

The number of nerves involved, the implication of certain groups of muscles or the immunity of others, may be of value in determining the site of the lesion—as to whether it is situated in the cortex, nuclei of origin, or base of the brain.

CENTRAL LESIONS.—A frequent symptom of cerebral affections, both irritative and destructive, situated above the nuclei of the ocular nerves is “**conjugate paralysis**,” that is a paralysis of the associated movements of the two eyes either upwards, downwards, or to one side. Lateral conjugate paralysees are by far the most frequent variety, and they may also occur as a symptom of nuclear disease; but the matter will be best understood if described here. Each sixth nerve nucleus controls the associated movements of the two eyes towards its own side by fibres which pass across the pons, and thence by the posterior longitudinal bundle reach the nucleus of the third nerve on the opposite side of the brain. From the third nerve nucleus, fibres containing strands from both nuclei are distributed to the cortex, their precise destination

being the bases of the first and second frontal convolutions. Conjugate paralysees from affections above the nuclei may occur in lesions widely separated, and, as they are usually very evanescent in character, they possess little clinical importance. When the lesion is situated in the pons or involves the sixth nerve-nucleus itself, however, the paralysis may be of a more permanent character.

It must be borne in mind that as the fibres decussate in the pons, to pass ultimately to the cortex of the opposite hemisphere, paralysis of conjugate movement to the right may be caused either by a *left* cortical or a *right* pontine lesion, and *vice versâ*. In cases of hemiplegia accompanied by conjugate paralysis, when movements to the right are *paralysed*, preponderance of action on the unaffected side will direct the eyes *towards* the lesion if cortical and *away from* the lesion if pontine or nuclear in origin; whereas, if the affection be an *irritative* instead of a destructive one, the opposite condition of things will occur, and spasmodic contraction of the affected muscles will drag the eyes over *to* the side of a nuclear and consequently *away from* a cortical lesion.

Conjugate paralysees are frequently accompanied by a rotation of the head in the same direction as the deviation, and it is also worthy of note that the paralysis does not usually affect the patient's power of convergence. The diagnosis of the site of lesion may be aided by remembering the evanescent character of the paralysis when of cortical origin, whilst in nuclear lesions there will probably be affections of other adjacent centres, such as those of the fifth or seventh nerves.

NUCLEAR LESIONS.—If we except conjugate paralysis, nuclear lesions are often most difficult to diagnose from basal affections of the nerves, and indeed in many diseases both nuclei and nerve-trunks are involved; whilst in others, again, the situation of the disease must remain a matter of doubt.

Two points, however, stand out as characteristic of nuclear lesions: firstly, the involvement of both nuclei as opposed to one-sided affections, which are more common in basal lesions; and secondly, the escape of some of the functions of the paralysed nerve, which is more likely to happen in nuclear than basal lesions. Thus nuclear paralysis may be said to be characterised by being *bilateral* and *incomplete*, though the latter feature may be lost in the progressive nature of the primary disease.

Ophthalmoplegia.—To the category of nuclear affections belongs a form of *progressive paralysis* of the ocular muscles, sometimes confined to these alone, but frequently extending to the nuclei of the seventh, eighth, and ninth nerves, and either occurring as a distinct disease or in the course of a diffuse nervous disease, such as tabes dorsalis. Both eyes are affected, and the disease usually commences with ptosis, and gradually spreads to the other muscles. When all the external muscles are involved the condition is known as "**ophthalmoplegia externa**," and the eyeballs remain rigid in the mid-line and are somewhat protosed from the muscular relaxation and loss of tone. In many cases the internal muscles of the eye, that is the sphincter of the iris and the ciliary muscle, escape; whilst in other cases the disease is confined to the internal muscles, which are alone paralysed, and the condition is then

known as **ophthalmoplegia interna**. When both the external and internal muscles are involved an **ophthalmoplegia universa** exists. Following on the ocular paralysis, facial and bulbar paralysis may slowly ensue, the disease gradually progressing, and extending over several years. Atrophy of the optic nerves may in some instances ultimately cause complete blindness. Syphilis and chronic alcoholism are said to be the most frequent causes. Occasionally the disease runs an acute instead of the chronic course above described, and causes death within a few weeks. Chronic ophthalmoplegia, when remaining confined to the eyes, is sometimes capable of improvement, or may even disappear under appropriate treatment when due to syphilitic disease.

Of nuclear origin are probably **Congenital Paralyses** of ocular muscles. They are generally but not always bilateral, and are often incomplete. The levator palpebræ is the muscle most commonly affected, and next to it the external rectus, whilst very rarely the superior rectus or superior oblique may be thus paralysed. Fuchs* states that congenital paralyses are remarkable in that they are not accompanied by contracture of their antagonists, and that therefore there is no squint unless the eyes are directed towards the paralysed side. This has certainly not been our experience in two cases, in which there was congenital paralysis of the external rectus with well-marked convergent strabismus on fixation.

In connection with congenital ptosis may be mentioned a curious condition in which the ptosis is associated with spasmodic attempts at elevation of the lid upon certain movements of the jaw, the reverse movement being accompanied by re-drooping of the lid. Marcus Gunn† was the first to describe a case of this sort, and a fair number of similar cases have been since recorded. The committee appointed to investigate Gunn's case considered that it was probably explained by some fibres of connection between the third and fifth nuclei. Sydney Phillips‡ has also recorded a case, in which on looking to the right the right lid remained raised, but the left drooped; and conversely when looking to the left the right lid drooped. This condition he ascribed to an unusually close connection between the nuclei of the third nerves.

Crossed or Alternate Fascicular Paralyses.—This term is applied to the symptoms that result from injury to the fibres of the third, fourth, or sixth nerves in the neighbourhood of the motor paths. The paralysis is termed "*crossed*" because the ocular paralysis is accompanied by hemiplegia of the opposite side, the lesion being on the same side as the ocular paralysis. If the third nerve alone is paralysed, the lesion can thus be located in the crus cerebri; if the fourth nerve, the neighbourhood of the valve of Vieussens; whilst paralysis of the fifth or sixth nerve with hemiplegia indicates a lesion in the pons.

BASAL LESIONS undoubtedly account for the largest number of ocular paralyses. As already stated, it is impossible with the present

* 'Text-book of Ophthalmology,' 2nd ed., p. 611.

† 'Trans. Ophth. Soc. U. K.,' iii, p. 283.

‡ Ibid., vii, p. 306.

state of our knowledge to diagnose with certainty a basal from a nuclear lesion, but the presence of other collateral symptoms may help. Thus an ocular paralysis accompanied by homonymous hemiopia or optic neuritis is in favour of a basal affection, though not diagnostic, and a motor paralysis accompanied by corneal anæsthesia or neuro-paralytic corneal ulceration from involvement of the ophthalmic division of the fifth nerve, is almost certainly basal. The history of a fracture of the skull, or the sign of a pulsating exophthalmos or of a cavernous thrombosis, will necessarily point to a diagnosis of basal injury. The paralysees that may occur in the course of meningitis or lead poisoning, or occasionally complicate a case of diabetes, when they are often evanescent in character and disappear if the diabetes improves under treatment; or the isolated paralysees that occur rarely as a sequel of influenza or chronic alcoholism, and in which also the prognosis is good, may all probably be classed under this head. Of all diseases, however, tertiary syphilis is the most frequent cause of basal ocular paralysees, from gummatous infiltration of the meninges or nerve-sheaths. It is doubtful whether post-diphtheritic paralysis of accommodation is to be regarded as a peripheral or a nuclear lesion (*see also* "Paralysis of Accommodation," page 407).

5. GENERAL DISEASES OF THE NERVOUS SYSTEM IN WHICH OCULAR AFFECTIONS ARE OF CLINICAL IMPORTANCE.

TABES DORSALIS.—This is the most frequent of all nervous diseases to affect the eyes. The onset of ocular symptoms is often early, before any signs of ataxia have appeared, though there is usually a history of lightning pains, disturbances of nutrition, loss of sexual power, and, on physical examination, blunting of sensation to pain, and Romberg's sign to aid the diagnosis.

It is necessary to bear in mind that tendon reflexes are frequently long retained in tabes, and therefore, though their abolition is a valuable diagnostic sign, their presence does not discount the diagnosis in the presence of other evidence of tabes.

Affection of the pupils is one of the earliest signs of tabes. They are smaller than normal (**spinal myosis**), and do not react at all or only very sluggishly to the stimulus of light, whilst they still retain their reaction to accommodation. This condition is known as the **Argyll-Robertson** pupil, from Professor Argyll Robertson, who first described it. The failure of the pupil to react to light often causes the patient to complain of increased difficulty when suddenly changing lights, as in going from a light into a dark room. The exact lesion which accounts for the A.-R. pupil is at present a matter of uncertainty.

Isolated paralysees of the external ocular muscles, probably of nuclear origin, are also frequent, the muscles supplied by the third nerve being most frequently affected. The paralysees are often transitory, or one muscle may recover to be succeeded by the paralysis of another.

The most serious ocular symptom is, however, **optic atrophy**, either occurring in both eyes at the same time, or the atrophy succeeding in

the second eye shortly after the first. The atrophy is of a primary non-inflammatory nature, and slowly progresses to complete blindness.

DISSEMINATED SCLEROSIS.—Ocular symptoms are frequently the earliest manifestations of this disease, and, indeed, years may elapse between their appearance and the onset of general symptoms.

The most frequent ocular symptom is perhaps **nystagmus**; but **bilateral optic atrophy** is also common, and is frequently associated with a central amblyopia and colour scotoma, due to a patch of sclerosis involving the papillo-macular nerve-fibres. Occasionally **paralysis of the external ocular muscles** may occur, but the Argyll-Robertson pupil is rarely if ever present. The paralyzes are probably nuclear in origin, as in the case of those which occur in tabes.

GENERAL PARALYSIS OF THE INSANE.—**Optic atrophy** is common, and the **pupils** are also often affected, being frequently unequal, variable in size, and reacting sluggishly to light and accommodation. Ocular palsies are rare, a point of importance in the differential diagnosis between this disease and lesions due to cerebral syphilis, in which the cranial nerves are commonly affected.

HYDROCEPHALUS.—Double **optic atrophy** and complete blindness is of fairly frequent occurrence in infantile hydrocephalus. We have also seen a case in which there was paralysis of the ophthalmic division of the fifth nerve, indicated by anæsthesia of the cornea with staphylo-matous bulging and neuro-paralytic ulceration. There was no paralysis of motion, but the eyes were quite blind.

ACROMEGALY.—**Bi-temporal hemiopia** has already been mentioned as frequently occurring in this disease. The hemiopia is due to hypertrophy of the pituitary body and its pressure upon the optic chiasma. Blindness from **optic atrophy** subsequently ensues; but the loss of sight may be very great without much alteration in the ophthalmoscopic picture of the discs. In one case at the present time under our observation the patient can only count fingers at two mètres, and can barely pick out the large letters of Jaeger 18, and, but for a certain bluish and opaque look, the discs might be passed as normal.

CEREBRAL TUMOURS.—**Bilateral optic neuritis** is the commonest and most important of the eye symptoms, and, as a rule, the swelling is very severe. **Isolated paralyzes** are not infrequent, the nerve most liable to be affected being the sixth, on account of its long intracranial course. In some cases there is **crossed paralysis**, which will indicate the situation of the tumour in the neighbourhood of the motor paths. With this exception eye symptoms have little localising value in cerebral growths (*see also* page 380). **Bilateral primary optic atrophy** is said to have occurred in a few cases; but it is exceedingly rare.

TUBERCULAR MENINGITIS.—**Bilateral optic neuritis** is very frequent in this disease; but it is usually of not so severe a character as

that observed in cerebral tumours, and is sometimes limited to blurring of the disc edges with slight increase in the bend of the retinal vessels as they cross the papilla. The optic neuritis may be accompanied by **isolated paralyses** of the ocular nerves, and in the later stages of the disease by deposits of **miliary tubercle in the choroid**.

POSTERIOR BASIC OR SIMPLE MENINGITIS.—In contradistinction to tubercular meningitis optic neuritis is a rare complication in this disease; but, on the other hand, the **child is frequently blind without any ophthalmoscopic evidence as to cause**. Lees and Barlow * think that this blindness may be due to inhibition of the optic radiations (see "Anatomy," page 378), and they also note that if the child survives the blindness usually passes off. **Paralysis of the third, fourth, or sixth nerves and nystagmus** are both fairly common, and more rarely the patient exhibits **conjugate deviations** of the eyes.

ACUTE CEREBRO-SPINAL MENINGITIS.—**Destructive inflammations of the uveal tract and neuro-retinitis** have been frequently observed.

SYRINGOMYELIA.—**Nystagmus** is a fairly frequent symptom, as is also **paralysis of the cervical sympathetic**, owing to the frequency with which the spinal cavity involves the upper dorsal cord (for symptoms of paralysis of sympathetic see page 392).

Ptosis and ocular paralyses are commonly met with. The paresis, however, may not become apparent until sustained efforts are made which involve the affected muscle.

SPASMUS NUTANS.—In this transient disease of infancy the shaking or nodding of the head is almost invariably associated with nystagmus. Dr. John Thomson † has recently drawn attention to a hitherto but little noticed point, *viz.* that the eyes frequently oscillate first towards and then away from each other, instead of the parallelism of the optic axes being maintained, as is usually the case in nystagmus. Thomson remarks that this *convergent* type of nystagmus points to the disease being in the main a co-ordination neurosis, for convergence in contradistinction to conjugate movements is an acquired act.

INFANTILE CEREBRAL DEGENERATION, OR AMAUROTIC FAMILY IDIOCY, is a rare disease of early childhood, of which one of the characteristic symptoms consists in symmetrical changes at the macula lutea. These retinal lesions were originally described by Waren Tay ‡ in 1881, but the primary disease was first brought into prominent notice, and its pathology worked out, by Risien Russell and Kingdon in 1897; § and still more recently a further account of the disease, with a collection of forty-two cases, has been published by Mohr. || The disease is characterised by a

* 'System of Medicine,' Allbutt, vol. vii, p. 521.

† 'Brit. Med. Journ.,' March 30th, 1901.

‡ 'Trans. Ophth. Soc. U. K.,' vol. i, p. 56; vol. iv, p. 158.

§ 'Trans. Med.-Chir. Soc.,' vol. lxxx, p. 97.

|| 'Arch. of Ophth.,' vol. xxix, p. 602.

progressive paralysis commencing in the first year of life and terminating fatally in from one to three years. It always exhibits a strong family predisposition, and appears to be chiefly if not exclusively confined to Jews. The lesion consists, in the main, of degeneration of the pyramidal cells of the cortex cerebri and of the pyramidal tracts of the cord. The retinal changes, which are not congenital, consist in the appearance of a whitish-grey patch about each macula, in the centre of which the fovea is very conspicuous as a dark spot much resembling the cherry-red spot noted in embolism of the central retinal artery. In the early stages no changes can be made out at the papilla, and light perception is present; but subsequently, definite optic atrophy and complete blindness supervene, whilst the changes at the macula persist unaltered until the close of life. Microscopically, the retina at the yellow spot is found thickened, owing to an enlargement or spacing out of the outer molecular layer suggestive of œdema (Collins), and Holden* has discovered degenerative changes in the retinal ganglion cells.

MIGRAINE.—A curious set of symptoms in some cases precedes an attack of migraine, which have collectively received the name of “**scintillating scotoma**.” The patient first notices that objects situated at the periphery of the field begin to scintillate, dance, or boil before the eyes. The scintillations or ebullitions gradually engage the whole field, and are accompanied or shortly followed by a scotoma on one side of the field, which soon develops itself into a well-marked homonymous hemiopia. These symptoms generally last for about half an hour, and then pass off to be superseded by the migrainous attack.

In the absence of definite evidence the symptoms are generally assigned to some circulatory disturbance in the cerebral cortex. In one case described by Leonard Guthrie† the migrainous attacks followed a severe fall upon the occiput, and persisted for years, finally disappearing entirely, to be replaced by symptoms characteristic of paralysis of the ocular sympathetic, *viz.* slight ptosis and narrowing of the palpebral aperture, slight recession of the globe, and slight myosis.

Fuchs‡ states that a glass of wine drunk quickly at the commencement will sometimes ward off one of these attacks; but no form of immediate treatment is of the slightest avail in many cases. Endeavours should be made to ascertain the conditions under which the attacks usually make their appearance, and the success of treatment will depend upon the possibility of combating these.

HYSTERIA.—Ocular symptoms are frequent and varied. The most common and perhaps the most troublesome is **asthenopia**. The patient complains of total inability to perform any work that requires accommodation or convergence for more than a few minutes. After this time violent headache or neuralgia in the eyes supervenes, and work has to be given up. Glasses do not improve the condition, and very likely the refraction is normal or nearly so. The diagnosis is made by the absence

* ‘Journal of Nervous and Mental Diseases,’ 1898, p. 550.

† ‘The Clinical Journal,’ 1896.

‡ ‘Text-book of Ophth.,’ 2nd edit., p. 499.

of any organic cause, either in the eyes or health of the patient, by its variability, and by other hysterical symptoms, whilst if we test the converging power we shall probably find it deficient. The asthenopia is often accompanied by general **Amblyopia**, or dulness of sight, so that the patient cannot be brought to a normal standard with glasses.

If the **visual fields** are tested, a diagnostic contraction may be found. The typical hysterical field is contracted equally in all directions so as to be roughly circular, and if the examination be continued, it will often be found to get progressively smaller until it is at last confined almost to the fixation point.

Conjugate deviation of the eyes is not uncommon in hysterical fits, but isolated paralyses, with the exception of ptosis, which is fairly frequent, are excessively rare if they occur at all.

Complete blindness is sometimes affirmed, but the presence of the pupillary reflex and the absence of ophthalmoscopic signs will bring the surgeon to a correct diagnosis, whilst other nervous symptoms, such as hysterical hemiplegia or hemianæsthesia, may also be present in these extreme cases.

A very useful test when only one eye is said to be blind, is that devised by **Harlan**. A trial spectacle frame with a weak concave lens (-0.25 D) before the bad eye, and a strong convex lens ($+10$ D) before the good one, is placed on the patient's nose, and he is asked to read with both eyes open. The strong convex lens before the good eye will prevent him from doing so if the other eye is really blind (*see also* "Malingering," page 26).

A common phenomenon is that of "**crossed amblyopia**," which consists of extreme contraction of the field on the hemianæsthetic side with slighter limitations on the other, combined, in many cases, with a complete or partial colour-blindness. In very rare cases hemiopic contraction of the fields has been described, but this symptom is almost invariably a pathognomonic sign of organic disease.

We have recently had under our observation a case of this sort in which a girl had been trephined three times—once over the mastoid, once over the cerebellum, and once over the motor area—for supposed cerebral tumour or abscess. Her sight was very bad, and double optic neuritis with post-neuritic atrophy was diagnosed. She also had complete left hemiplegia and hemianæsthesia. After the third trephining, the result of which was only to aggravate symptoms, the patient was discharged from hospital and recommended for an incurable home as completely blind and hopelessly paralysed. She then came under our care. Examination of the eyes revealed a perfectly normal fundus with no evidence of pre-existent disease, and pupillary light reflex was well marked, although the patient professed to be unable to tell light from darkness. Suspicion as to the real nature of the case was aroused, and our colleague Dr. Risien Russell carefully examined the nervous symptoms. As no evidence of organic disease could be found, it was determined to try the Weir-Mitchell treatment. After this treatment for three weeks the patient was perfectly well; could walk without any difficulty and read J. I with the greatest of ease with either eye. Shortly afterwards she left the hospital, and we heard no more of her for a few months, when we learnt indirectly that, feeling ill again, she had consulted another doctor, and that she was then convalescing from a fourth trephining operation, presumably for another hypothetical cerebral abscess.

The treatment of the ocular symptoms in hysteria resolves itself into that of the disease generally. Asthenopia is very troublesome, and in many cases will continue in spite of all treatment, the patient going from doctor to doctor, but never persevering with anything. The Weir-Mitchell method of treatment answers well in many cases.

RECURRENT PARALYSES OF OCULAR NERVES.—This is a term given to an obscure and interesting class of cases. The affection generally commences in early childhood or youth, and is characterised by attacks of severe one-sided headache and vomiting, which may last a variable time, from a few hours to several days; and which are accompanied or followed shortly by a corresponding paralysis, usually of the third and rarely of the sixth nerve. The paralysis is generally complete or nearly so, and lasts an indefinite time, usually disappearing completely in a few weeks after the early attacks, but gradually leaving permanent impairment as the attacks recur.

The paralysis may in occasional cases involve more than one nerve, as in three cases reported by Holmes Spicer and Ormerod,* who published seven cases in all, and tabulated the records of thirty-one other cases. In one of these the facial was involved with the sixth nerve; in a second complete ophthalmoplegia externa of both eyes resulted after a series of recurrences; whilst in the third the paralysis affected both third and sixth nerves.

Of the pathology of this disease little is at present known. Our knowledge may be summed up in Holmes Spicer and Ormerod's words—"The weight of the evidence seems to point to some local lesion at the base of the brain, the nature and seat of which are possibly not constant, and are as yet undetermined."

CEREBRO-SPINAL RHINORRHŒA.—This is a name given by St. Clair Thomson,† who has recently published a case and elaborated all that is known of an obscure disease characterised by the persistent dropping of cerebro-spinal fluid from the nostril. This draining may go on for years without any apparent ill-consequences, but in eight of the twenty-one published cases it was associated with optic neuritis and atrophy. Thomson is of opinion that the fluid leaks through the perineural sheaths of the branches of the olfactory nerves, but nothing is definitely known of the ætiology or pathology of the disease.

6. OCULAR SYMPTOMS IN AFFECTIONS OF THE CERVICAL SYMPATHETIC.

The cervical sympathetic, besides supplying fibres for the dilatation of the pupil, the course and distribution of which have already been discussed (*see* article on "The Pupil"), supplies vaso-motor branches to the eye and furnishes filaments to a thin layer of unstriped muscle in the upper lid (Müller's muscle) which aids the action of the levator palpebræ.

Paralysis of the cervical sympathetic may follow the pressure of tumours in the neck, such as aneurysms, enlarged cervical glands, goitre, sarcomata, etc.; or it may occur from section of the nerve in wounds or operations. In other cases it may be seen as an isolated group of symptoms, the origin of which it is difficult to trace,—as in a case reported by Leonard Guthrie, to which reference has already been

* 'Trans. Oph. Soc. U. K.,' vol. xvi, p. 277.

† 'The Cerebro-spinal Fluid: its Spontaneous Escape from the Nose.'

made (page 390), and in which the paralysis appeared upon the cessation of attacks of migraine which for many years had followed a fall upon the occiput. In another case which we have recently seen in a young baby it was apparently due to the pressure of forceps used in delivery, and in another it slowly supervened after an operation for simple bronchocele.

In a well-marked case there is slight drooping of the upper lid and consequent narrowing of the palpebral fissure. The globe is somewhat receded in the orbit (enophthalmos), and the pupil is moderately contracted, and will not dilate after the instillation of cocaine, though responding to the action of atropine. Defective secretion of sweat is also frequently noticed on the side of the lesion. Conversely, in irritative lesions of the cervical sympathetic the upper lid is retracted and the palpebral fissure widened, the eye is protruded and staring, and the pupil moderately dilated. The first three signs are prominent features in exophthalmic goitre.

CHAPTER XXIV.

AFFECTIONS OF THE EXTRINSIC OCULAR MUSCLES.

ANATOMY.—The extrinsic muscles of the eyeball are six in number—(1) superior rectus, (2) inferior rectus, (3) internal rectus, (4) external rectus, (5) superior oblique, (6) inferior oblique. With the exception of the inferior oblique they all arise from the anterior margin of the optic foramen. The inferior oblique arises from a small depression upon the orbital surface of the superior maxilla close to the nasal duct.

The four recti pass forwards, and are inserted by delicate tendons into the sclerotic about a quarter of an inch behind the corneal margin, the internal rectus having a slightly more anterior insertion than the external. The superior oblique runs along the inner wall of the orbit, and anteriorly passes as a delicate tendon through a fibrous pulley known as the “trochlea,” and attached to the frontal bone. At this point it changes its direction, and passing directly backwards ends by a broader expansion into the sclerotic about midway between the cornea and the point of entrance of the optic nerve, and just *behind* the equator of the eyeball between the superior and external recti. The inferior oblique passes outwards and backwards to a point adjacent to, but a little posterior to, the superior oblique, between the inferior and external recti, where it ends by a tendinous expansion inserted into the sclerotic.

Capsule of Tenon.—Each muscle before its insertion receives an important investment from Tenon's capsule. This consists of a loose membranous sac forming a bursa upon which the eyeball moves with the least possible friction, as a ball in a socket, and investing the whole globe as far forwards as the cornea. Anteriorly it blends at the corneal margin with the ocular conjunctiva; posteriorly it surrounds and blends with the optic sheath; between these points it is loosely connected internally to the eyeball by delicate areolar tissue forming a large lymph-space directly continuous with that of the optic sheath; whilst externally it rests against the orbital fat. Each muscle tendon perforates the capsule as it passes to its insertion into the sclerotic, and receives from it an investing sheath, which is prolonged backwards upon the muscle for some distance, and ends by gradually blending with the fascial sheath. This reflection over the muscle-tendons is of much importance in operations upon the ocular muscles.

From the capsular investment of each rectus fibrous bands pass to the adjacent orbital walls; those passing from the internal and external recti to the lacrymal and malar bones respectively being the strongest, and known as the internal and external *check ligaments*. Their use is to inhibit excessive muscular action, and to support Tenon's capsule and with it the globe, during the contraction of the muscles, which would otherwise tend to draw the globe backwards. The action of the superior rectus is further checked by fascial bands, which connect it anteriorly with the levator palpebræ, whilst that of the inferior rectus is limited by fascial attachment to the lower lid.

Nerve-supply.—The internal, inferior, and superior recti, and the inferior oblique are supplied on their ocular surface by the third or oculo-motor nerve. This is the largest of the three motor nerves which supply the muscles of the eye. It passes through the sphenoidal fissure in two divisions, the superior passing forwards to supply the levator palpebræ and superior rectus, whilst the remaining muscles are supplied by the inferior division, which also furnishes the motor root of the lenticular ganglion. Through this latter branch spring the ciliary nerves which supply the intrinsic muscles of the eye, *viz.* the ciliary muscle, and the sphincter pupillæ.

The superior oblique is supplied by the fourth or trochlear nerve, which enters the orbit by the sphenoidal fissure, and, running close to the orbital periosteum, enters the muscle on its orbital surface.

The external rectus is supplied by the sixth or abducens nerve, which passes through the sphenoidal fissure between the two heads of origin of the external rectus, and supplies it on its ocular surface.

(For the anatomy of origin and intra-cranial course of the ocular nerves see "The Motor and Sensory Paths," page 383.)

Actions of the Ocular Muscles.—The movements of the eyeball take place round three principal axes.

1. *Vertical Axis.*—These movements are known as abduction and adduction, and are mainly performed by the external and internal recti respectively.

2. *Horizontal Axis.*—Movements around this axis cause elevation and depression, and are mainly undertaken by the superior and inferior recti respectively.

3. *Sagittal Axis.*—This is an antero-posterior axis, the movements around it being of a wheel-like or rotatory nature, the chief agents being the superior oblique for inward and the inferior oblique for outward rotation.

The external rectus is a pure abductor and the internal rectus a pure adductor of the globe. The actions of the other muscles are more complicated, and each embraces movement round more than one of the principal axes.

The superior and inferior recti, though inserted in the mid-line, arise on the inner side of the orbit, and so pursue an outward course across the orbit. Consequently in their contractions they exercise an oblique traction, and besides elevating and depressing the eyeball, they turn the anterior half slightly to the inner side (adduction), and also

slightly rotate the whole globe inwards in the case of the superior rectus, and outwards in the case of the inferior rectus.

The superior oblique also pursues an outward course from its reflexion at the trochlea to its insertion. As the latter is *behind* the equator of the globe, the muscular contraction imparts a contrary movement to the *front* of the eye. It elevates and adducts the posterior half, so that the anterior section of the eye looks downwards and outwards. It has, in addition, a wheel-like action, which it exercises on the whole globe alike, rotating it inwards.

The inferior oblique is likewise inserted *behind* the equator, and its course is also obliquely outwards. Acting from below, it depresses and adducts the section of the eye behind the equator, causing the anterior portion to be elevated and abducted, whilst at the same time it rotates the whole eye outwards.

Thus it will be seen that every movement of the eye is complex, and brings into play the associated contraction of two or more muscles.

Abduction chiefly by the external rectus aided by the superior and inferior obliques.

Adduction chiefly by the internal rectus aided by the superior and inferior recti.

Elevation chiefly by the superior rectus aided by the inferior oblique.

Depression chiefly by the inferior rectus aided by the superior oblique.

Rotation outwards chiefly by the inferior oblique aided by the inferior rectus.

Rotation inwards chiefly by the superior oblique aided by the superior rectus.

The movements of the two eyes are also closely associated, and are presided over by a special centre. The innervation of one muscle always brings into action a corresponding, but not always similar, muscle in the other eye. For example, the innervation of one internal rectus may either cause innervation of the other internal rectus, producing convergence of the optic axes, or it may stimulate the external rectus, causing a conjugate deviation of the eyes.

PRISMS AND THE DECENTRATION OF LENSES.

In the treatment of muscular affections of the eye prisms play a very important part, and a short description of their uses is therefore appended at this point. The same effect as placing a prism before an eye may be produced by "decentring" a lens, and this method is often employed in preference.

Prisms.—Rays of light in passing through a prism are deflected towards its base (*see* page 2). Hence if a prism be placed in front of the eye with its base inwards towards the nose, the rays, being bent towards the nose, will be brought to a focus at a point internal to the yellow spot, and the *object* will consequently be projected unduly outwards. The patient now has diplopia; but in order to unite the two images and bring them on to corresponding points of the two retinae he squints

involuntarily outwards, and if the prism be not too strong he in this way succeeds in overcoming the outward displacement of the object, and in fusing the two images. The strabismus produced in this way is called a "*corrective squint*." Conversely, if a patient comes with diplopia from an outward squint, it is possible to cure the diplopia by placing a prism of sufficient strength, base inwards, before the squinting eye. The action of prisms, otherwise very puzzling, will be easily understood by bearing in mind the two following simple rules:

1. A prism always produces deviation of an *object* in the direction of its *apex*.
2. Corrective efforts must come from the side towards which the apex looks.

Prisms are now numbered by their angle of deviation. Thus a prism of one degree deviation causes an object situated at one mètre to alter its apparent position 1 cm. in the direction towards which its apex is placed. A prism of two degrees deviation will shift such an object placed at the same distance 2 cm., and so on. Deviation prisms are about double the strength per unit of the old numbering. Only deviation prisms are meant in this article when the strength is stated. Prisms are used—

1. To ascertain the presence of binocular vision (*see* page 26).
2. To test and measure the strength of the ocular muscles.
3. To correct the deviations of heterophoria and paralysis.

Prism-strength of Muscles.—The most powerful muscle is the internal rectus, which by a corrective squint can overcome a prism of 12° to 15° with its base outwards. The external rectus can overcome a prism of from 4° to 6° , whilst the vertical muscles are the weakest, and can only fuse the image from a prism of 1° to 2° , with the base either upwards or downwards.

By comparing a patient's prism power with the standard of normal muscles we are enabled to judge of any weakness in a particular muscle group, but we must guard against a patient only using one eye or suppressing the false image. It is therefore best to have a coloured slip of glass before one eye to help to differentiate the two images. A very convenient method of carrying out this experiment is to use a rotary prism (Fig. 180), which consists of two prisms placed in apposition and rotated against each other by a wheel, so that the effect is produced of a single prism of increasing or decreasing strength, according to the relative positions of the two prisms to each other. The total effect at any position of the prisms is recorded on a marginal graduated index.

To correct Heterophoria and Paralysis prisms correcting the diplopia are worn as spectacles. In heterophoria the correcting prism is halved between the two eyes, but in paralytic cases the prism is worn entirely before the deviating eye. Strabismus due to palsy of the sixth nerve or to partial paralysis of the third nerve, in which the internal

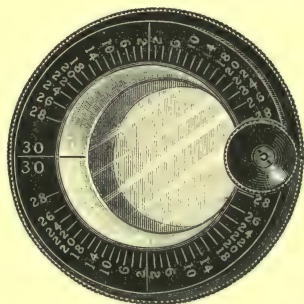


FIG. 180.—Riseley's rotary prism.

rectus is the muscle solely or principally affected, and where, from special reasons, the patient objects to keep the eye covered to avoid diplopia, is the paralytic condition in which prisms are of especial service. The spectacles should be furnished with a piece of plain plate glass for the sound eye, and with a rightly adjusted prism for the paralytic one. Whilst using the prism the patient should be kept under observation, as, if the case is progressing to a favourable termination, the prism will require to be frequently changed for another of a lower degree as the paralysed muscle gradually regains power, until at last its use may be abandoned.

It is worth remembering that it is usual in prescribing prisms to mark the axis in which they are to be worn by the position of the base; that is, base inwards or upwards, etc., as the case may be.

Decentration of Lenses.—A spherical lens may be said to consist of two prisms placed base to base in a biconvex, and apex to apex in a biconcave lens (*see* “Elementary Optics”). If the lens is so cut that a patient looks through some part of the lens other than the centre, a prismatic effect is produced, and the lens is said to be *decentred*. The character of such a prism will depend on the nature of the lens, whether

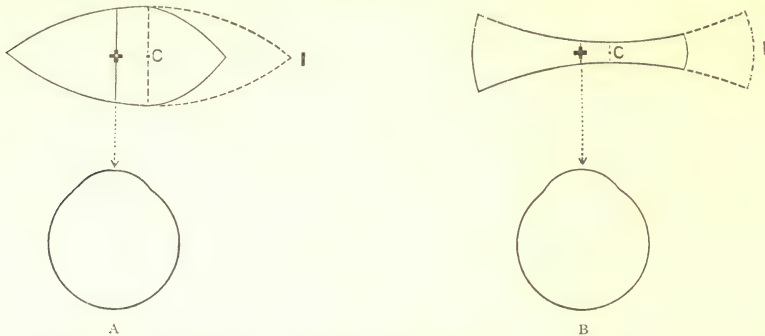


FIG. 181.—A. Decentration inwards of a biconvex lens. B. Decentration inwards of a biconcave lens. c. Optical centre of the lens. i. The inner side of the lens. The dotted line marks the circumference of the lens before decentring.

biconvex or biconcave, and also upon the direction of the decentring; whereas the *strength* of the prism will depend upon the amount of the decentring, and will increase in direct proportion with the dioptric measurement of the lens. For example, if a biconvex lens is decentred *inwards*, the *optical* centre of the lens is displaced inwards; the eye looks through the apparent centre of the lens which is to the outer side of the optical centre, and the effect produced is that of a prism with the base inwards (*see* Fig. 181 A). Were the lens a biconcave one, the effect of decentring inwards would be the reverse, *viz.* that of a prism with the base outwards (*see* Fig. 181 B). Consequently it is a complicated matter in practice to gauge the exact amount of decentration required for a particular case, though tables have been drawn up for the purpose; and the matter is best left to the optician, the surgeon simply stating the character and strength of the prism required.

Maddox* gives an easy rule for remembering the direction in which the lens should be decentred in any particular case.

Displace — lenses with the deviation of the eye.

Displace + lenses against the deviation of the eye.

If only a slight amount of lateral prismatic action is required, it can be obtained by making the centres of the spectacles slightly too wide or too narrow instead of actually decentring the lenses. Thus narrowing the centres of spectacles is equivalent to slightly decentring the lenses inwards. This is a useful thing to remember in ordering reading glasses for old feeble people, for by prescribing their convex spectacles to be made with slightly narrowed centres we give them a weak prism, base inwards, which relieves their convergence. A most undesirable form of prismatic action of this sort is often seen in children who have outgrown their spectacles, the centres of which have consequently become too narrow; and in cases of concomitant squint it is one of the causes of failure to cure by spectacles.

STRABISMUS (SQUINT).

Donders defined strabismus as a “deviation” in the direction of the eyes, in consequence of which the two yellow spots receive images from different objects.

The deviation is generally convergent or divergent, either purely lateral or more rarely combined with some rotation of the eyes in an upward or downward direction. Completely vertical deviations are rare.

There are two great classes of strabismus.

1. **Paralytic** strabismus, in which the deviation is due to the paresis of one or more of the ocular muscles.

2. **Non-paralytic**, or **concomitant** strabismus.

The movement which the squinting eye makes when the sound eye fixes an object is termed the **primary deviation**. If the sound eye be screened and the patient told to fix an object with the squinting eye, the former will in its turn squint behind the screen, and this movement of the sound eye is termed the “**secondary deviation**.” In concomitant squints the primary and secondary deviations are equal to one another; but in paralytic squints the secondary deviation is always greater than the primary; because the increased amount of innervation required to produce a contraction of the parietic muscle, being equally exercised upon the normal associated muscle of the other eye, will produce an abnormal amount of contraction in the latter.

To estimate the extent of deviation several methods have been devised, of which the two following are the most generally employed, and are sufficient for all requirements.

Estimation in Millimètres.—A simple instrument known as a strabismometer is employed, consisting of an ivory or metal plate moulded to the conformation of the lower lid, and set in a handle. The upper border is graduated in millimètres from each side of a central point, which is designated as zero. The squinting eye is now

* ‘Tests and Studies of the Ocular Muscles,’ page 376.

made to fix some object at a distance of 4 to 6 mètres by screening the other eye, and the strabismometer placed against the lower lid so that zero corresponds to the vertical diameter of the pupil. The good eye is now freed, whereupon the squinting eye immediately resumes its false position, and the number of millimètres it has deviated inwards or outwards from zero, as noted by the new position of the vertical pupillary diameter, is recorded as the amount of inward or outward squint.

The Angular Method, or Estimation in Degrees.—This is more accurate, but requires a perimeter. The patient is seated before the perimeter as for estimation of the visual field, and asked to look at some distant object directly in front of and on a level with the eyes. If the surgeon now holds a candle flame in the line of fixation (A) of the sound eye, he will, with his own eye behind the flame, observe a reflected image of the flame in the centre of the pupil of the fixing eye (L), whilst the flame reflex in the squinting eye (R) will be displaced to the outer or inner side of the pupil, according as its deviation is outwards or inwards respectively. The arm of the perimeter (BC) is now placed horizontally on the side towards which the squinting eye is directed; thus, if the right eye is squinting inwards (as in Fig. 182), the perimeter arm is placed on the patient's left. Whilst the patient still fixes the object the surgeon moves the candle along the perimeter arm, keeping his own eye close behind the flame until he reaches a point (S) where the candle reflex is seen to occupy the centre of the pupil of the squinting eye. This gives

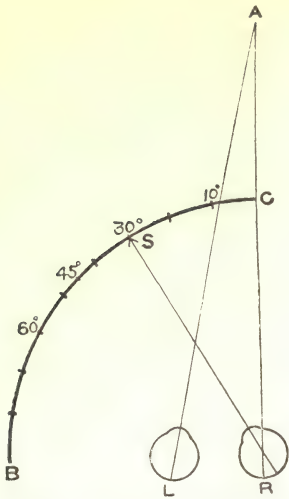


FIG. 182.—The measurement of the squint angle. (See Text.)

him the direction of the optical axis of the squinting eye (SR) and the angle of the squint (SRA). The size of this angle can be read off in degrees, which are marked along the arm of the perimeter or baseline (SC). In the case illustrated in Fig. 182 the angle (SRA) is seen to measure 30° .

It will be obvious that neither of these methods enables us to estimate a vertical deviation. The usual way of testing these is to mark the difference of level of the pupils of the two eyes with reference to the free border of either the upper or lower lid. By this method we can get a very fairly accurate measure in millimètres.

PARALYTIC STRABISMUS.

To thoroughly understand this subject the reader must first be well acquainted with the action of each individual muscle on the movements of the globe, a short description of which will be found on page 395.

The subject of paralysis of the separate nerves which supply the muscles of the eye is involved in considerable obscurity, as although in many cases the cause of the paralysis is clear, yet in others it is difficult to assign any satisfactory explanation for the sudden or gradual loss of power in the structures supplied by one particular nerve, and the third, fourth, or sixth nerve may become paralysed without there being evidence of disease in any other portion of the nervous system. The loss of power may be sudden, or it may be gradual, the paralytic symptoms increasing daily until they have reached a certain point, at which, for a time, they usually remain stationary. After a variable interval the nerve may begin to recover its tone, and the parts supplied by it may ultimately resume their normal action.

The immediate result of paralysis of one of these nerves is a strabismus, caused by a loss of the balance between the muscles of the affected eye. This is termed a **paralytic strabismus**, to distinguish it from those forms of squint which are due to some anomaly in the refraction of the eye. The paralytic strabismus has this characteristic, that whereas in the concomitant squint the primary and secondary deviations are equal, in the paralytic the secondary is greater than the primary (*see also* page 399).

General Symptoms.—If the patient be directed to cover the sound eye with the hand and then to walk across the room, he will suffer more or less from vertigo, and frequently to such an extent as to cause him to stagger in his gait like a drunken man. This inability to co-ordinate the action of the muscles under the direction of the paralysed eye is most marked when the palsy of the nerve is complete. In cases of diplopia from commencing paralysis of an ocular nerve, when there is a difficulty in deciding which is the affected eye, a rapid and correct diagnosis may be often made by telling the patient to walk a short distance with his hand placed first over one eye and then over the other. The affected eye is the one which, when the other is closed, induces vertigo.

Diplopia.—This is a distinctive characteristic in paralytic strabismus in contra-distinction to concomitant strabismus, where the false image is suppressed. The diplopia is either **homonymous**, *i. e.* the false image is projected outwards, so that, if emanating from the right eye, it is seen on the right or outer side, and on the left if proceeding from the left eye; or the diplopia is **crossed**, *i. e.* the false image is projected inwards, across the nose, so that it is seen to the left of the true image if emanating from the right, and to the right if proceeding from the left eye. It is by the character of the diplopia, whether homonymous or crossed, and by the various positions of the eye in which diplopia is present, that we diagnose what muscle or muscles are affected. Consequently the estimation of the diplopia is of the highest importance; and as the matter is often complicated and difficult, especially when more than one muscle is affected, a few general hints will be of service before proceeding to describe the various paralyses of individual muscles. The diagnosis is aided by placing a piece of coloured glass before one eye, to differentiate the images, and by using a lighted candle in a dark room to make them as distinct as possible.

1. *Firstly make out which is the faulty eye.* Direct the patient to follow the candle held by the surgeon, which is moved in various directions. The faulty eye will halt, or its movements become defective in certain positions, which are noted.

2. *Ascertain in which directions diplopia is seen*, and where most marked. This should correspond with the directions of faulty movement. The extent of the diplopia, that is the separation between the images, always increases as the eyes are directed towards the paralysed muscle.

3. *Is the diplopia crossed or homonymous?* Cover one eye and ask which image disappears;—if the right image when the *left* eye is screened, then the diplopia is crossed; if the right when the *right* eye is covered, it is homonymous.

4. Remember that—(a) *the false image, not being formed on the macula, is more indistinct than the true*; (b) *the deviation of the eye is always in the opposite direction to the projection of the false image*. Thus, if the eye squints upwards, the false image is projected downwards or below the true image.

5. *All squints which are wholly or partially outward*, from paralysis of inward-moving muscles, produce *crossed* diplopia, whilst conversely all inward squints produce *homonymous* diplopia. Thus in paralysis of the internal, superior, and inferior recti the diplopia is *crossed*; but in paralysis of the external rectus and the superior and inferior obliques the diplopia is *homonymous*.

6. *The false image is on the same or on a different level to the true image.* It is only in the case of the internal and external recti that the false image will be on the same level as the true one. In paralysis of elevating muscles, the superior rectus and inferior oblique, with downward deviation of the eye, the false image will be projected above the other; and in paralysis of the depressors, the inferior rectus and superior oblique, it will, on account of the upward deviation of the eye, lie on a lower level.

7. *The false image is erect or tilted.* The tilting of the false image is due to a paralysis of rotation round an antero-posterior axis, and as all the ocular muscles with the exception of the internal and external recti have some action in this respect, paralysis of the latter are the only examples in which the false image is erect. This is true for all positions of the eyes in paralysis of the internus and externus excepting in *oblique* movements of the eyes towards the paralysed side, an exception that is explained below.

The direction of the tilting is very puzzling unless the cause is clearly understood, and a brief explanation is therefore necessary. It will be remembered that inward rotation is under the control of the superior rectus and superior oblique, whilst outward rotation is governed by the inferior rectus and inferior oblique (*see* page 396). It follows that the tilting observed as the result of paralyses of the first two muscles is contrary in direction to that seen in paralyses of the last two. As the projection of the false image is in the opposite direction to the deviation, paralysis of inward rotation, in which the defective eye is outwardly rotated as compared with the other, will cause the false image to appear tilted *inwards*; and paralysis of outward rotation will cause it to

be tilted *outwards*. In other words, if the obliques are at fault, paralysees of which are accompanied by homonymous diplopia, the false image in the case of the superior oblique, an inward rotator, will lean inwards or towards the true one; and in the case of the inferior oblique, an outward rotator, will lean outwards or away from the true one. With regard to the superior and inferior recti, it must be borne in mind that the diplopia is crossed and the false image displaced to the other side of the true one; and consequently the false image, whilst leaning in the same direction in paralysis of the superior rectus as in paralysis of the superior oblique, and in paralysis of the inferior rectus as in that of the inferior oblique, will in the case of the superior rectus be tilted away from, and in the case of the inferior rectus will lean towards the true image (see Fig. 184).

It only remains to explain the slight tilting, mentioned above, that occurs in oblique movements of the eye towards the paralysed side in paralysees of the external and internal recti.

Let us take the case of the external rectus first. If the paralysed eye is directed upwards and outwards or downwards and outwards, it is only able to perform effectively the vertical portion of the movement, and consequently is not rotated outwards by the inferior oblique as it should be. The result of this is that the defective eye is in a position of slight inward rotation as compared with the other, just as happens in the case of paresis of the inferior oblique, and for the same reason the false image appears tilted outwards or away from the true one. The same thing happens

if the eyes are directed downwards and outwards, only in this case it is the superior oblique that is unable to act properly, and as a result the false image is tilted inwards or towards the true one.

In paralysis of the internal rectus, tilting of the false image will similarly take place if the eye is directed upwards and inwards or downwards and inwards; but in this paralysis it is due to a *preponderance* of rotating influence which the obliques assume on account of the outward lagging of the eye. Therefore the tilting of the false image is *towards* the true one on attempts to look up and in, and *away from it* when the eye is directed down and in.

There is also a slight alteration in the level of the false image in the oblique movements of a paralysed abductor or adductor, but this may be disregarded.

8. *Position of the Head*.—The diplopia may be somewhat limited by turning the head, and the latter is generally carried rotated in the direction opposite to that assumed by the squinting eye.

9. The diagnosis will be simplified in difficult cases by noting down

R	UP & TO R	UP	UP & TO L	L
	R	CENTRAL	L	
	DOWN & TO R	DOWN	DOWN & TO L	

FIG. 183.—Schematic chart for recording alterations in the position of the false image. The right and left refer to the patient, who faces the surgeon, and are therefore transposed in the chart for the sake of clearness.

the character of the diplopia in the nine chief meridians of the visual field, which should be tested severally and in order. This is easily done by constructing a small chart on the principle illustrated in Fig. 183). Another and ingenious aid to memory is afforded by Werner's mnemonic diagrams of ocular paralyses, which are easily constructed, and show the position of the false image in paralysis of any one muscle at a glance (Fig. 184).

Causes of Paralytic Strabismus.—These are very numerous and difficult to classify. As already said, there are a certain number of cases for which we can find no adequate cause; but the majority of cases can be grouped under one of the subjoined headings.

1. *Congenital.*—The levator palpebræ of one or both eyes is the muscle most commonly affected. As the muscle acts upon the upper lid and not the eye itself, this form of paralysis will be considered in the article on "Ptosis" (page 471). The external rectus is not uncommonly either absent or ill-developed. Very rarely a similar condition affects the superior rectus or superior oblique (*see also* page 386).

2. *Intra-cranial Disease.*—Here we have to consider all the affec-

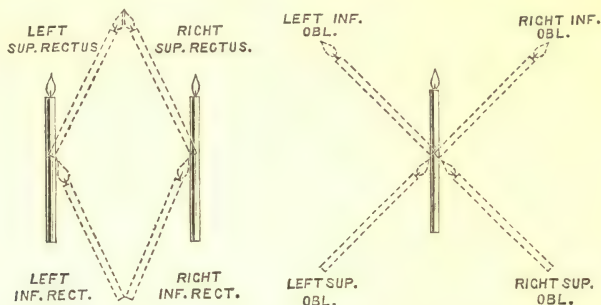


FIG. 184.—Werner's mnemonic diagrams of ocular paralyses.

tions that may cause pressure on the nerves in their intra-cranial course from their nuclei of origin to the sphenoidal fissure. Such pressure may be caused by sarcomata, gliomata, collections of fluid or pus, hæmorrhage, aneurysms, especially arterio-venous aneurysm about the cavernous sinus, tubercular or syphilitic deposits at the base of the brain, or gummata of the nerves themselves. Tabes dorsalis and disseminated sclerosis may also cause isolated paralyses (*see also* Chapter XXIII on "The Eye in Diseases of the Nervous System").

3. *Intra-orbital Disease.*—Here also a variety of causes may operate. Syphilitic deposits, either as gummata or periosteal nodes, the exudations from orbital cellulitis, or pressure from orbital tumours, either arising from the orbital tissue proper or in connection with the optic nerve. Lastly, pressure may be exercised from without, and upon the orbital contents, as in tumours of the antrum, ethmoidal cells, or frontal sinus.

4. *Diphtheritic Paralysis.*—This most frequently affects the ciliary muscle (*see* page 407), but the external muscles may be similarly affected.

5. *Rheumatic Paralysis.*—This is a general term applicable to a

fairly large class of cases in which the paralysis seems to follow exposure to wet and cold. Such paralysees of the ocular nerves are analogous to a similar affection of the seventh nerve.

6. *Traumatic*.—Occasionally paralytic symptoms are due to penetrating wounds of the orbit, or to fracture of the base of the skull, especially in fracture of the middle fossa or in a fracture involving the walls of the orbit.

7. *Functional*.—Ptosis is sometimes noticed in hysterical patients (see “Hysteria,” page 391).

Diagnosis of Cause and Site of Lesion.—This is often most difficult and sometimes impossible to determine when other symptoms are vague. It is most important to inquire carefully into the history, particularly as regards syphilis, which is the most frequent of all causes, especially when ocular paralysis is the only symptom. In many cases the ocular paralysis is only one of many signs, all of which must be carefully considered before a correct diagnosis can be formed. The reader is further referred to Chapter XXIII on “The Eye in Diseases of the Nervous System.”

We will now proceed to the consideration of the **special symptoms** indicative of paralysis of the various muscles, and these will be grouped under the headings of their particular nerve-supply.

I. PARALYSIS OF THE THIRD NERVE (MOTOR OCULI).—When the paralysis is **complete**, there is an absolute loss of power in all the structures of the eye supplied by the third nerve. The levator palpebræ being paralysed, the upper lid droops over the eye, and cannot be raised by the patient (ptosis). The superior, inferior, and internal recti, and the inferior oblique muscles, have ceased to exercise any control over the movements of the globe, and the eye is under the dominion of the external rectus and the superior oblique, which, acting together, draw the globe outwards and slightly downwards. A strong divergent strabismus is thus given to the eye, and the patient has crossed diplopia, the false object appearing across the nose on the other side of the true one. But in addition to this the pupil is widely dilated, and from paralysis of the ciliary muscle the accommodation is suspended. From the complete relaxation of so many of the ocular muscles, there is generally a slight protrusion of the globe. If the patient be directed to close the sound eye, he will generally walk with an unsteady gait, and miss the objects he endeavours to seize.

Such are the symptoms of a complete paralysis of the third nerve; but it is seldom, except in cases of cerebral disease or of tumours in the orbit, that all the branches of the nerve are thus affected.

Partial paralysis of the third nerve may exist in two forms.

a. There may be a diminution rather than an absolute loss of power in all the structures which the nerve supplies, and the patient then exhibits the symptoms already described, but in a modified degree. The ptosis is only partial; the pupil is dilated, but not to its utmost, and the accommodative power of the eye is diminished; there is a divergent strabismus with crossed diplopia, but it is not extreme,

and with an extraordinary effort the patient can draw the eye either slightly inwards, upwards, or downwards.

b. In many cases, however, of partial paralysis of the third nerve, some only of its filaments are affected. The loss of power may be

RIGHT INT. RECTUS.



LEFT INT. RECTUS.



FIG. 185.—Paralysis of the internal rectus. The dotted figure represents the false image.

confined to one or more of the recti muscles, any one of which may be separately paralysed; but the palsy is seldom if ever limited to the inferior oblique. The muscle which is the most frequently involved is the internal rectus; it is rare for the superior or inferior rectus to be paralysed whilst the internal muscle remains intact. The pupil

is generally more or less dilated, but occasionally is uninvolved; the levator palpebræ frequently retains its influence over the upper lid, even when one or more of the muscles of the eye are paralysed. There is always some diplopia, the false object varying in position with respect to the true one, in accordance with the muscle or muscles which have lost their power. Thus—

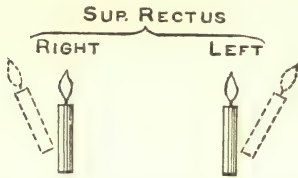


FIG. 186.—Paralysis of the superior rectus. The dotted figure represents the false image.

In paralysis of the **internal rectus** alone (Fig. 185) there is a divergent strabismus, but the eye can be turned upwards or downwards. The diplopia is crossed, and the false object is on a level with the true one, except in oblique movements towards the paralysed side (*see* page 403).

In paralysis of the **superior rectus** alone (Fig. 186) the eye is displaced downwards and outwards by the combined action of the inferior and external recti and superior oblique muscles whenever an attempt is made to look up. The diplopia is crossed, the false object is above the level of the true one, and tilted with its upper end *away* from the true image.

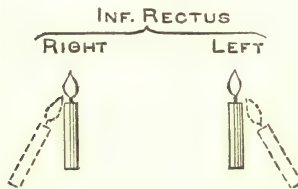


FIG. 187.—Paralysis of the inferior rectus. The dotted figure represents the false image.

In paralysis of the **inferior rectus** alone (Fig. 187) the eye deviates upwards and outwards by the combined action of the superior and external recti and the inferior oblique muscles when an effort is made to look down. The diplopia is crossed, the false object is projected below the level of the true one, and tilted with its upper end *towards* the true image.

- In paralysis of the **inferior oblique** alone (Fig. 188) the eye deviates slightly downwards and inwards on upward movements, and diplopia appears when looking above the horizontal line. The diplopia is homonymous, the false image being above the true one, with its upper end inclined *away* from the true image.

Paralysis of the accommodation (cycloplegia) may occur alone, and is then usually the result of diphtheria or syphilis. When due to the former it is always bilateral, and generally unaccompanied by dilatation of the pupils or other ocular palsy. Syphilitic cycloplegia, on the other hand, is often unilateral, and is generally associated with mydriasis. Cycloplegia may also be due to the action of mydriatics (*see* page 190).

Paralysis of convergence is excessively rare as an isolated ocular palsy, except as a functional disturbance, when it is very common (*see* "Heterophoria," page 424).

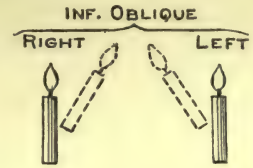


FIG. 188.—Paralysis of the inferior oblique. The dotted figure represents the false image.

2. **PARALYSIS OF THE FOURTH NERVE (TROCHLEAR).**—In paralysis of the fourth nerve the early symptoms are often obscure and easily overlooked; but when the palsy is complete they are usually sufficiently marked to be diagnosed by a careful examination of the eye. It should be remembered that the function of the superior oblique in health is to roll the eye downwards and outwards, and that therefore no defect of sight arising from a want of power in this muscle will be noticed by the patient so long as his eyes are fixed on objects above the horizontal mesial line (Fig. 189).

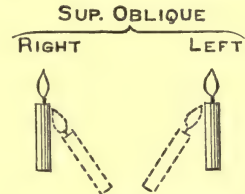


FIG. 189.—Paralysis of the superior oblique. The dotted figure represents the false image.

The symptoms which characterise palsy of this muscle are that whenever an attempt is made to look downwards the affected eye is drawn slightly upwards and inwards, and the patient has homonymous diplopia, the false object appearing to the outer side and below the level of the true one, and with its upper end slanting towards it. The interval between the true and false impressions, both in latitude and elevation, is increased as the globe is vertically depressed.

3. PARALYSIS OF THE SIXTH NERVE (ABDUCENS).

—In paralysis of the sixth nerve there is a marked internal strabismus; the eye, when the palsy is complete, cannot be drawn outwards beyond the mesial line of the orbit, but it can be turned freely in all other directions. There is homonymous diplopia, the false image being projected to the outer side of the true one, and it is erect, except in oblique movements of the eye towards the paralysed side (*see* page 403). If, with the sound eye closed, the patient endeavours to seize an object, he misses his aim, the hand passing to its outer side (Fig. 189).

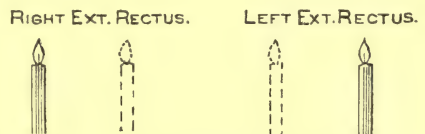


FIG. 190.—Paralysis of the external rectus. The dotted figure represents the false image.

Prognosis of Ocular Paralysis.—This is influenced by many considerations. Speaking generally, the prognosis may be regarded as favourable in cases due to syphilis, rheumatism or gout, diphtheria or hysteria. When the ocular paralysis is a symptom of serious intra-cranial or intra-orbital mischief other than syphilitic, the prognosis must be considered unfavourable. In all cases the extent of the paralysis and its duration are important points. It is more favourable if the paralysis is only partial, and limited to one ocular nerve. If the loss of power has been persistent, and no improvement has taken place in spite of judicious treatment, the prognosis is unfavourable. There are, however, many cases in which recovery progresses to a certain point and then ceases; the paralysed muscle does not completely regain its former tone, and a slight strabismus with diplopia remains. For such patients much may be done by local treatment.

Treatment of Ocular Paralysis.—If the paralysis is due to syphilis, rheumatism, gout, or diphtheria, the patient must be treated constitutionally with the medicines suited to these special diseases. In most cases benefit is gained from small and repeated doses of the iodide, or the iodide and bromide of potassium, or of the iodide of potassium combined with iron. The bowels should be freely opened by a purgative, and counter-irritation may be used behind the ear, either by rubbing in a stimulating liniment or by applying a small blister. In syphilitic cases, pil. hydrarg. subchloridi comp. gr. v may be given every other night for a short time, or a little of the unguent. hydrarg. may be rubbed night and morning into the temple of the affected eye.

Radical operative measures form the only chance of relief when the symptoms are due to pressure from intra-cranial or intra-orbital tumours other than those caused by syphilis.

To relieve the diplopia, which is so distressing to the patient, the affected eye should be excluded, either by being covered with a bandage, or by the use of a pair of spectacles with large curved glasses, one of which has been completely darkened. In certain cases when only one muscle is affected, and especially if the paralysis is only partial, prisms are of the greatest service in uniting the double images, but it must be remembered in using them that they will have to be repeatedly changed if the palsied muscle gradually regains its power. The strength of the required prism will be best estimated by Maddox's rod test (*see* page 426), and it must be placed with its apex pointing in the direction towards which it is desired to shift the false image.

When the paralysis is probably dependent on a local affection of the nerve, as from some rheumatic or gouty effusion, faradisation or the constant current is often of the greatest service, but it should not be recommended if there is any reason to suspect cerebral disease.

In some cases the muscle, having regained a certain amount of power, ceases to improve. When this happens, and the strabismus and diplopia have continued stationary for some months, an operation may be performed with advantage, to restore the balance of power between the muscles. If the paralytic strabismus be divergent, the external

rectus may be divided, and the internal rectus brought forward in the manner recommended on page 421. In convergent strabismus tenotomy of the internus with advancement of the affected muscle may be performed. In congenital paralyses advancement of the defective tendon, if it can be recognised, is the procedure most likely to be of benefit.

CONCOMITANT STRABISMUS.

Concomitant strabismus is so called because the deviation or squint accompanies equally all movements of the eyes in fixation. It thus differs widely from paralytic squints in which the deviation varies directly in amount with the position of the eyes, according as they are turned towards or away from the paralysed side.

We are often told by mothers that the child squints with both eyes. This is obviously impossible in concomitant squint, where the fixation power of one eye is never impaired. The mistake arises from the fact that some children squint indifferently with either eye, with the right when looking to the left, and *vice versa*.

Concomitant squints are either (1) **periodic**, (2) **alternating**, or (3) **monolateral**. Squint is usually developed gradually;—the child learns to squint. At first he may only squint on occasions when tired or not well, or when accommodating, and the squint is then said to be *periodic*. After a time the child will give up all attempts at binocular vision and squint constantly, but very likely with either eye—the squint *alternates* between the two eyes. Ultimately the child recognises that it is less trouble to always use one eye in preference to the other, probably because the vision in one is rather more acute, and the squint will then become *monolateral*,—that is, it will be confined permanently to one eye.

This is the common sequel of events, but in a certain number of cases, when one eye from some cause is very inferior to the other, the squint may be monolateral from the first; or again, the squint in a few cases may continue indefinitely of a periodic and alternating character.

Absence of Diplopia.—This is a constant feature of concomitant squint. There are two theories to account for it: either there is total mental suppression of all images formed by the squinting eye; or the images are perceived and diplopia really exists, which the patient has learnt to disregard. Arguments in favour of both views may be advanced.

Amblyopia.—It frequently happens that the squinting eye is very inferior to the other in visual acuity without any apparent cause. Formerly all such eyes were said to suffer from "*amblyopia ex anopsia*," or dull sight from non-use. Such an explanation is purely hypothetical, and though perhaps partly true for some cases, it does not account for a considerable number of others in which the defect is noticed in quite early childhood. In these the amblyopia must be regarded as a congenital defect, not necessarily in the peripheral visual apparatus, but more probably in the higher percipient centres, and it is noticeable

how often this kind of amblyopia occurs in dull and backward children. It must necessarily be a matter of uncertainty to what extent amblyopia is a cause or effect of squint until we devise some method of ascertaining the causation of the amblyopia itself.

Range of Movements.—As a rule this is perfect in every direction; but it sometimes happens in monolateral squints of long standing that there is actual limitation of movement in the squinting eye, and its range outwards if the squint is convergent, or inwards if the squint is divergent, is restricted. In convergent squint this is generally the result of long-continued stretching of the external rectus, which weakens its contraction; but in divergent strabismus there is usually in addition an inherent weakness of converging power which must be taken into account. The range of both vertical and horizontal movements may be tested with the perimeter by seeing how far the patient, keeping his head immovable, can turn the eyes so as to read small letters marked on a card, which is moved along the perimeter arc through different meridians. The method is fully described on page 48. The range of the two eyes, which in each eye normally amounts to nearly fifty degrees in every direction, may thus be compared.

CONCOMITANT CONVERGENT STRABISMUS.

Ætiology.—Between 70 and 80 per cent. of all cases of convergent strabismus occur in conjunction with hypermetropia. This frequent association led Donders, who was the first to thoroughly describe the affection, to unite them in the position of cause and effect, and his theories until a recent date were generally accepted as the most satisfactory explanation of the phenomenon of convergent squint.

Donders' Theory.—Donders held "that convergent squint was due to an imperfect dissociation of the associated acts of accommodation and convergence in hypermetropia. The hypermetropic eye must necessarily accommodate for every visual act, and each effort is accompanied by an impulse to convergence proportionate to the innervation of accommodation. This converging impulse is an inconvenience; for though the hypermetrope must accommodate for any object more than the emmetrope, yet to maintain binocular vision he must only converge his visual axes as much as the emmetrope; and so he is placed in the difficulty of either abandoning clear sight in order to maintain binocular vision, or of sacrificing the latter; in which case, by throwing the excess of associated convergence upon one eye, and so causing it to squint inwards, clear monocular vision is obtained with the other. Every hypermetrope has to make his choice unconsciously between these two, and the choice is intuitively in favour of squint when there is marked inferiority of one eye to the other, either from an opacity of the media or some other cause."

Though Donders' theory probably partly explains the origin of convergent squint, yet there are several reasons why it cannot be accepted as a complete or satisfactory solution. In the first place, all very young children are probably hypermetropic, many only to a

slight extent, but only a small proportion of hypermetropes squint. Secondly, squint is more frequent among hypermetropes of the medium than among those of the highest degrees, though we should expect the reverse to be the case with Donders' theory; and thirdly, convergent squint sometimes occurs in myopic and emmetropic patients, and occasionally in blind eyes, anomalies for which Donders' theory does not account at all. Squint in the very large majority of cases commences in early childhood. Priestley Smith* found that 219 out of a total of 261 cases occurred before the seventh year, the commonest age of onset being the fourth year, and we have frequently encountered cases in early infancy during the first months of life. In other words, squint most commonly appears when a child is actually learning the acts of accommodation and convergence. The equal adjustment of the two eyes for fixation is the product of a highly delicate innervation, and like other complicated nervous acts, such as walking, must be gradually learnt. Thus children who are born blind are never able to fix properly, and generally exhibit nystagmus or ill-controlled movements of the eyes. It is easily conceivable that a slight cause will suffice to disturb this delicate act of co-ordination in a young child, and in many cases we get a direct history of such a cause from the mother, who tells us that the squint supervened after some illness, such as measles, whooping-cough, convulsions, or some gastric derangement. Moreover we should expect this co-ordinate act to be the more easily disturbed when prejudiced either by a marked defect in one eye, when there is less object in maintaining it, or by a hypermetropic error, in which there is increased difficulty in doing so.

Again, Priestley Smith has pointed out that the amount of the squint bears no relation to the amount of refractive error, and that it is generally in excess of what can be accounted for by Donders' theory, a fact that is best explained on the ground that squint, being an act of inco-ordination, is, as is always the case in such acts, uncontrolled and violent. Thus, though we may assume that Donders was correct in his association of hypermetropia and squint as cause and effect up to a certain point, yet it is certain that no mere mechanical theory completely explains the origin of convergent squint. In all cases faulty innervation plays an important part, and in no inconsiderable number of cases it is the predominating factor.

Treatment.—There are three methods of treating convergent squint.

(1) **Optical**; (2) **Educational, or Orthoptic**; (3) **Operative**.

Our great aim should be to cure the squint by the first two methods, leaving operative measures for those cases in which they have failed. Until a few years ago it was the general practice to operate on all squints by tenotomies and advancements; but now that it is recognised that squint is as much due to faulty co-ordination as to mechanical causes, we should reserve operative means for special cases. We should endeavour not merely to "put the eyes straight," but to restore

* 'Trans. Ophth. Soc. U. K.,' vol. xviii.

binocular vision. The latter we can only hope for in a comparatively small number of cases; but attempts in this direction should always be made when there is the least chance of success. From a cosmetic point of view, too, the straightening of the eyes must be much more accurate and satisfactory when obtained by restoring the nervous equilibrium than the results acquired by artificial means; and further, the risk of over-correcting the deformity, and so producing a squint in the opposite direction, which, in slight or moderate squints, is a source of very real danger in operating upon young subjects, is avoided. In a large number of cases non-operative measures will partially succeed, and then we are obliged to resort to operation to complete the cure. Optical and educational methods are most likely to be of service when the deformity has only existed a short time, and the patient is young, *i. e.* has not passed the period of growth, and when there is no marked visual difference between the two eyes. Thus periodic and alternating squints in young people are the most favourable for these forms of treatment, whilst monolateral or amblyopic cases are not likely to be much benefited, especially if the patient is twenty years of age or more.

1. **Optical Treatment.**—Squints arising in very early life, during the first and second year, not infrequently get well of themselves, especially if recourse be had to atropine. This drug, by suspending accommodative efforts, will also stop the child from its attempts at convergence, and the eyes being placed in a state of physiological rest, matters will often readjust themselves. The pupils should be kept well dilated by a little Ung. or Guttæ Atrop. (F F. 57, 10), which should be used every night and morning. This treatment should be continued over a lengthy period. Even if no apparent benefit follows, it is best to persist in this treatment until the child is about three years of age, when any error of refraction should be corrected by suitable glasses. We personally never order glasses before this age, on account of the danger of the child falling and breaking the glasses into the eye. In children over three years of age we may proceed at once to the correction of the refraction under atropine, and glasses should be ordered for constant wear, which should be large and round to prevent the child looking over and round them. Frequently very marked improvement at once follows the full correction of the refraction, due to the curative effects resulting from the adjustment of the accommodation and the consequent restoration of the balance between accommodation and convergence. In many periodic and some alternating cases the squint will be gradually cured by optical means alone.

2. **Orthoptic Treatment.**—It is primarily to Javal that we owe the expansion of the educational treatment of convergent strabismus, and many brilliant successes have followed. The chief drawback is that it requires time, intelligence, willingness, and great perseverance on part of both patient and teacher, and it is consequently not well adapted in completeness for hospital practice. Even in private practice the number of suitable cases is very limited, but when practicable, and

combined with optical treatment, it offers the best chance for restoration of binocular vision. There are three methods: (1) the **shade**; (2) **bar-reading**; and (3) **training with the stereoscope**. To obtain the best result the shade should be used in combination with one of the other two; but the shade is the only method adapted to hospital work.

a. Shade.—By this means we endeavour to train the squinting eye in the fixation of objects. A vulcanite disc is slipped over the glass in front of the *non-squinting eye*, or a simple shade over the eye itself if no spectacles are worn. It should at first be used only intermittently for two hours or so until the child becomes accustomed to its use, and only employed when the child is not at work or reading. In a short time the child will find fixation with the squinting eye not so burdensome, and the use of the shade can be gradually extended to half a day, or worn persistently for a time. Perhaps the best method after the child has become accustomed to its use is to wear the shade for three hours twice a day, thus allowing a short space between, during which the second method—bar-reading—may be practised.

b. Bar - reading.—If we place a pencil or some such object between our book and our eyes and shut one eye, we notice that the pencil shuts out some words, and that we are obliged to move the head or pencil in order to distinguish them. If we open the other eye, and have binocular single vision, we shall be able to continue reading without either moving the head or pencil; the image on one retina supplying that shut out from the other by the pencil. A patient with a squint is in the position of one who has one eye shut, and the first benefit of the bar is to make the patient cognizant of his defect, and so to awaken a desire for binocular vision. At the first lessons bar-reading can only be carried out with difficulty by repeatedly closing the non-squinting eye, and so forcing the squinting eye to fix the print, no dodging of the head being allowed. As the power of fixation comes back, so the patient gradually learns to employ the fixation power of both eyes together, and when he can read with the bar without any hesitation or movement of the head, we may be certain that he has binocular vision. A most convenient and simple kind of bar is one devised by Priestley Smith, and consists of a thin strip of metal bent in two places at a right angle, so that it can be held on a book with the thumb or forefinger, and slid up or down as desired (Fig. 191).

c. Training by the Stereoscope.—The object of the stereoscope is firstly to make the patient aware of the image in his squinting eye,

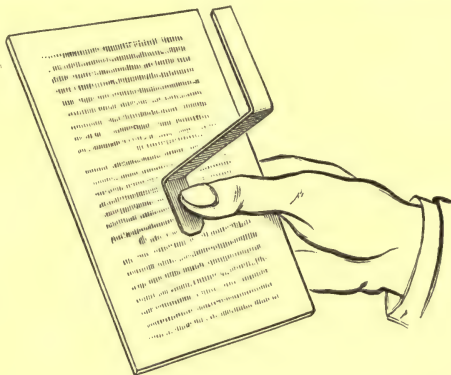


FIG. 191.—Priestley Smith's reading bar.

which he normally suppresses; and secondly, having thus rendered him conscious of diplopia, to teach him to fuse the double images.

The best form of instrument is Landolt's (see Fig. 192), which consists of an ordinary box stereoscope with slots attached to the sight-holes, into which lenses of any required strength may be slipped, and with, in the place of the ordinary views, two simple objects which can be approximated or separated from each other by a sliding movement, their distance apart being registered on a fixed centimètre scale attached to the base of the stereoscope. The two objects should be sufficiently dissimilar to ensure accuracy when the patient says that he can see both; but at the same time, in order to help the desire for fusion, they should form component parts of a single picture, such as

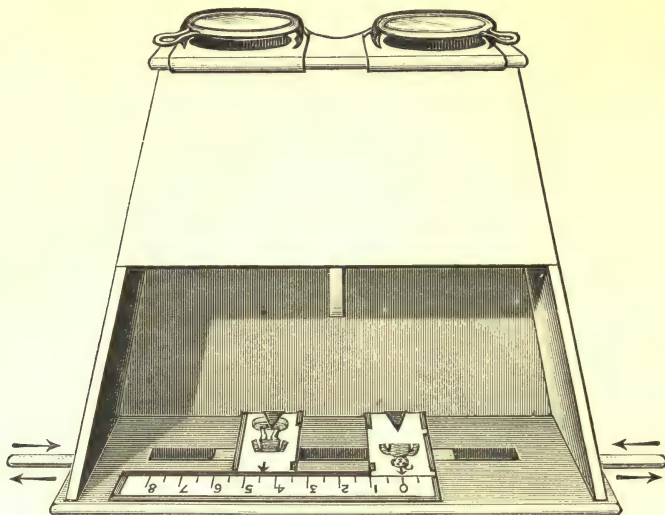


FIG. 192.—Landolt's stereoscope.

the two halves of a human figure. A series of specially adapted pictures can be purchased with the stereoscope.

The first step is to make the patient, who is wearing his correcting glasses, see the two objects by approximating or separating them as the case may be, and, as soon as he is able to do this with certainty in all positions of the objects, we may proceed to teach him exercises for fusing them after the method laid down by Landolt,* which is as follows:

In the first instance, the two objects are separated for a distance about equal to that between the two eyes. To fuse these objects into one necessitates parallelism of the lines of fixation, which is generally only possible when no accommodative effort is being employed. As the stereoscope measures 16 cm. in length, it will therefore be necessary to supply before the sight-holes, lenses of a dioptric strength equivalent to the amount of accommodation required to maintain binocular vision at

* 'The Refraction and Accommodation of the Eye,' p. 408.

16 cm., which, by the ordinary rule, amounts to + 6 D ($\frac{100}{16} = 6$). Should the patient be ametropic, he will, if hypermetropic, require in addition the lens that corrects his refractive error; and if myopic, a corresponding deduction from the + 6 D will be needed, so that a hypermetrope of + 4 D will require a lens of + 10 D, and a myope of - 4 D a lens of + 2 D. The ametropic patient must either, therefore, wear his correcting glasses or make the necessary alteration in the lenses placed in the sight-holes of the stereoscope.

It will be noticed that most patients will still be unable to fuse the objects on account of a certain amount of persisting convergence. If this is so, the patient is directed to approximate the objects until fusion is obtained, when the distance that the objects are now apart should be noted, and at successive sittings endeavours should be made to obtain fusion at a gradually increasing distance, until at last the patient succeeds in doing so without the least convergence,—that is to say, at a distance equal to that between his two eyes.

When this point is reached the patient has acquired binocular vision for distance, and it now remains to try and obtain it when accommodation and convergence are called into play. For this purpose the lenses before the sight-holes are reduced one dioptré, inducing an accommodation of this amount and a convergence which has its equivalent in about 1 cm., to which extent the objects should be approximated. If fusion can be maintained here, the lenses are still further reduced and the objects correspondingly approximated until at last they are brought together and can be fused when in this position. From what has been said, it is evident that this feat will require the exertion of six dioptries of accommodation, which the emmetrope should effect with his naked eyes and the ametrope by the aid of his correcting glasses.

3. Operative.—These measures consist in tenotomy of the internal rectus of the squinting eye alone, or combined with internal tenotomy on the other side and advancement of the antagonistic muscle (external rectus) in the squinting eye. Speaking broadly, it is advisable not to operate before the child is about ten years of age. The exact effects of tenotomy are very difficult to gauge in childhood; they are apt to increase slowly for some years, and in numberless cases, especially a few years ago, when tenotomy was practised recklessly, over-correction and a consequent divergent strabismus resulted.

In deciding what procedure should be adopted, a few points will be of service.

1. Remembering the danger of subsequent increasing effect, do not be tempted to do too much at one sitting.

2. It is right to leave two or three degrees of convergence after tenotomy.

3. The effects of a simple tenotomy of the internal rectus can be considerably modified by the method of performing the operation. To produce the smallest effect, the muscle is divided as near as possible to its insertion with the least possible disturbance of parts behind and internal to the insertion, so that the muscle forms a re-attachment

close to its former one. To produce the greatest effect the fascia around the muscle is freely divided, so that the tendon is allowed to slip back. A free tenotomy may be sufficient to correct a deviation of twenty degrees.

4. Correcting glasses and the use of the shade, etc., should be continued after operation.

5. If simple tenotomy of the internal rectus of the squinting eye has proved, or is likely to prove, insufficient, there are three courses open.

a. Tenotomise the internal rectus of the other eye.

b. Advance the insertion of the external rectus of the squinting eye at the same sitting as the tenotomy of the internal rectus of the squinting eye, or later on.

c. A combination of both measures, but not at the same sitting.

The following considerations will guide us:

If the squinting eye is markedly amblyopic, it is best to confine treatment as far as possible to that eye alone.

If both are good seeing eyes and the squint moderate— 20° to 30° ,—the best plan in most cases, including all children, is to first tenotomise the other internal rectus. If this is not sufficient at once, wait some months at least in the case of a child, and continue with former measures, and a cure may still ultimately result. It is most likely to be unsuccessful in extreme squints originally over 35° , and in a few cases where there is actual loss of power in the external rectus—a complication rarely seen in children, but not very uncommon in adults when the squint has existed for several years without treatment.

If the squint be originally very extreme— 35° to 45° ,—or in squint of lesser degree when the squinting eye is very amblyopic, or when there is loss of power in the external rectus, advancement of the tendon of the externus will probably be needed either at the same sitting as the tenotomy of the squinting eye or later on. This should always *precede* tenotomy of the internal rectus of the fixing eye when the squinting eye is amblyopic. It is not advisable to attempt advancement in patients under about eighteen years of age, as it is best to operate under cocaine only, so as to gauge the effects produced at the time of operation, and young children cannot be kept under control without general anæsthesia. Slight convergence should be still left after the operation is completed, for the ultimate results will be slightly greater than the immediate.

(For the methods of performing tenotomy and advancement see page 418, *et seq.*)

CONCOMITANT DIVERGENT STRABISMUS.

Ætiology.—According to Donders about two thirds of all cases of divergent strabismus are due directly to myopia. The part played by myopia in producing divergence is described in discussing heterophoria (see page 425), and there is a great tendency for unrelieved exophoria to develop into an absolute squint. Divergent squint is occasionally seen with hypermetropia, and in these rare cases its origin

is very difficult to explain. It is probable that they are analogous to the similarly rare cases of convergent squint in myopia, and that both classes of cases are to be explained as anomalies resulting from loss of proper co-ordinating or balancing power.

The influence of refractive error is much more evident in divergent than in convergent squint, and in contradistinction to what we observe in convergent squint, the tendency to divergence seems to definitely increase with the degree of myopia. This is not only due to the increased tendency to insufficient convergence that accompanies increase in myopia, but also to visual defects from destructive fundus changes, which in the high degrees of myopia frequently produce great inequalities of vision between the two eyes. As myopia is an acquired defect coming on during growth, so concomitant divergent squint from this cause is very rare in young children under six years of age.

There remains a class of cases in which a divergent squint is due to opacities in the media or other causes productive of blindness. In some cases, as already pointed out, squint originating in this way may be convergent, but as a rule the tendency for blind eyes is to diverge.

Treatment.—Non-operative measures are usually of no avail in these cases. In most, the very nature of the defect which produces the squint stultifies all attempts at orthoptic treatment, either because clear binocular vision cannot be maintained for close work without a convergence which the patient is utterly unable to support; or because, in those cases which result from opacities, etc., in the media or a diseased condition of the fundus, the absence of any interest in maintaining binocular vision, which has caused the squint, will prevent its cure. Something may, however, be hoped for by orthoptic and optical treatment in the rare cases of divergence which occur in association with hypermetropia, and at any rate these methods should have fair trial. So, too, in all cases of myopic divergence suitable glasses for distant and near vision should be ordered, which, by checking the myopia, may prevent further increase in the divergence.

Operative Treatment.—In slight cases, tenotomy of one or both external recti may be sufficient, particularly if the strabismus is periodic; but external tenotomy is disappointing because the internal recti are often unable to take full advantage of the operation. An indication of the value of external tenotomy is afforded by testing the power of convergence. If no movement takes place in the squinting eye, tenotomy is not likely to be of service. In severe monolateral cases the only treatment likely to be of any benefit is an external tenotomy, accompanied at the same sitting by an advancement of the internal rectus. This operation is very successful from a cosmetic point of view, but from what has been already said it will be gathered that such cases as require it will not be benefited visually. It is worthy of note that there is not the same danger of over-correcting the squint in advancement of the internal rectus as in that of the external rectus. The innervation of the internal rectus is too weak in these cases to allow the muscle to assume excessive control, and the difficulty in many cases is to advance the tendon sufficiently to cure the defect.

Divergent Strabismus as a Result of Operation.—This may occur after too free an advancement of the external rectus, or from the division of both internal recti when one only was required, or it may follow a too free division of the subconjunctival fascia, or it may arise from the tendon having been divided at too great a distance from its insertion into the globe. In both of the last-mentioned cases the muscle recedes too much, and takes its new insertion into the globe so far back that it loses more of its power than is necessary for the correction of the squint, and consequently gives to the external rectus a predominance which makes the eye diverge.

It is also probable that the extreme divergence which occasionally follows the division of one or both of the internal recti muscles may be due to the tendon of one or both muscles not having contracted a firm union to the globe, but having become united to it through the medium of a thin fibrous tissue which admits of great stretching. In such cases the internal recti lose power, and the eyes gradually fall under the control of the external recti, which draw them completely outwards.

With this form of strabismus there is nearly always associated a sinking back of the caruncle, a defect which gives an unsightly prominence to the globe, and favours its eversion.

Treatment.—If divergence follow shortly after an operation for a convergent strabismus, in which the internal recti *of both eyes* have been divided, a subconjunctival tenotomy should be performed on both the external recti, and this should be done even though the divergence be slight, as when once established the eversion will steadily increase. If, however, the divergence is the result of a too free division of the internal rectus and adjacent tissues of *one eye*, then the external rectus of that eye only should be divided. If simple tenotomy fails, as will always be the case whenever the divergence is considerable and the power of inversion limited, then search must be made for the cut end of the internal rectus tendon, and the latter re-attached. The operation is difficult.

When too free an advancement of the external rectus is the cause of divergence, a dissection to set back the advanced tendon, combined the day after operation with convergence and adduction exercises, may be sufficient, as in one case under our care. This can only be successful if the divergence is slight, because the tissues become much matted together after an advancement. If this fails, a counter advancement of the internal rectus may be attempted, or one or two broad subconjunctival sutures inserted on the inner side, and kept in as long as possible.

TENOTOMY.

The operation for strabismus that we prefer is the one most frequently adopted at the Royal London Ophthalmic Hospital. It is strictly a subconjunctival operation, in the sense that the division of the tendon is accomplished beneath that membrane, the opening in it

for the introduction of instruments being opposite the superior or inferior edge of the tendon according to the position of the operator.

Instruments.—Speculum (Fig. 130); two pairs of toothed forceps (Fig. 132), the second pair for an assistant to rotate the globe if necessary; blunt strabismus hook (Fig. 194); pair of straight blunt-pointed scissors (Fig. 193).

Operation.—The surgeon may stand in front or behind the patient as he finds most convenient. Only cocaine is needed, unless the patient is nervous or a child, when general anæsthesia is to be preferred. The lids are separated by the speculum, and the patient told to look over well to the opposite side, or if a general anæsthetic is given, an assistant may rotate the globe in the required direction. The surgeon takes hold of a vertical fold of the conjunctiva, and, at the same time, of the deep fascia over the lower or upper edge of the insertion of the rectus tendon, and with a pair of blunt-pointed scissors makes a small opening through both these structures, the cut being directed towards the globe. If the fascia has escaped the scissors, it must be seized with the forceps and divided. The blunt hook is now passed through the apertures in the conjunctiva and deep fascia, and behind the tendon, which it renders tense by being made to draw it forward and towards the cornea. The points of the scissors are next to be introduced, and, slightly separating them, one blade is passed along the hook behind the tendon and the other in front of it, when, by a succession of small snips, the tendon is divided subconjunctivally on the ocular side of the hook.

The operation is now completed; but before drawing the speculum Sir W. Bowman usually made a small counter-puncture in the conjunctiva, by bulging it on the end of the hook in the situation of the

opposite border of the tendon after its division, and by then snipping it with the scissors; the object being to allow any of the effused blood immediately to escape, instead of diffusing itself over the sclerotic.

This operation is equally applicable to the division of either the internal or external rectus muscle. It must, however, be remembered that the tendon of the external rectus is inserted into the globe in a line much farther back than that of the internal muscle.

In cases of strongly marked divergent strabismus we frequently

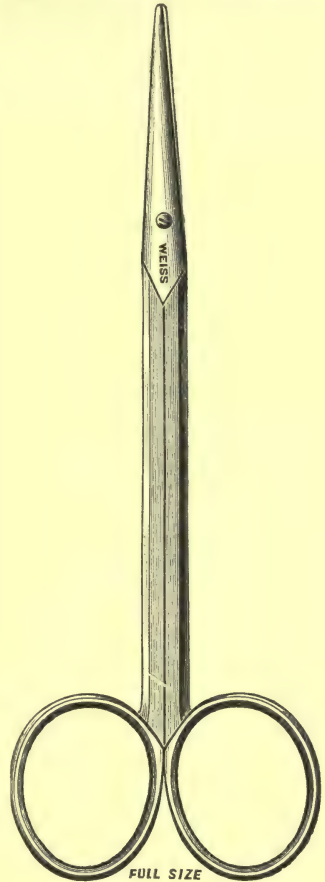


FIG. 193.—Strabismus scissors.

divide the external rectus muscle external to or behind the hook. To do this the tendon is first exposed by a vertical cut through the conjunctiva with the scissors; the hook is then passed beneath the tendon, and the latter divided with the scissors on the outer side of the hook. The piece of tendon which is left connected with the globe is cut off to avoid an unseemly prominence, which would otherwise remain.

The opening in the conjunctiva is then closed with one or two fine sutures, as may be required.

Graefe's Operation for Strabismus.—The eyelids having been separated by a speculum, the assistant with a pair of forceps draws the eye outwards if the internal rectus is to be divided, and inwards if the operation is to be on the external rectus. The operator then, with a pair of finely-toothed forceps, seizes hold of a fold of the conjunctiva and subjacent tissue close to the cornea, and at a point a little below the centre of the insertion of the muscle. This he cuts through with a pair of scissors slightly curved on the flat, and then, burrowing with their points a little distance above and below the opening he has made, he freely detaches with a few snips the subconjunctival tissue from the muscle. The strabismus hook is now passed beneath the lower border of the tendon, which is to be divided with the scissors as close as possible to its insertion into the globe. After the tendon has been cut through, the divided conjunctiva should be raised with one hook, whilst the operator with another hook explores the wound both upwards and downwards, to see if any part of the tendon or of its lateral expansion has escaped division. If the whole tendon has been cut through, the exploring hook will glide readily up to the margin of the cornea; but if its progress should be checked by catching behind some undivided part of the tendon, the scissors must be again used to sever that which still remains uncut.



FIG. 194.—Strabismus hook.

Difficulties and Dangers Attendant upon the Operation.—These are few, but important.

1. *There may be an unsightly sinking back of the caruncle* after the tenotomy is completed. It occurs when there has been free division of the conjunctiva and subconjunctival tissue, and is best remedied by uniting the divided ends of conjunctiva with a fine suture.

2. *If the conjunctival wound is allowed to gape*, an exuberant granulation may grow from the exposed subconjunctival tissue. It must be snipped away with scissors, and its base lightly touched with the mitigated silver stick, or the conjunctiva drawn over the site, if possible, by a suture.

3. *The tenotomy may have been too free.* The patient should always be able to converge after an internal tenotomy, though not so powerfully as before. If the operated eye will not converge at all, or even

deviates slightly upon attempts at convergence, too much has been done. The best method is then to bring the parts about the wound together by one or two broad sutures, including the subconjunctival tissue.

4. *The effect of the tenotomy may appear too little.* In this case we may increase the effect by a conjunctival suture on the opposite side.

5. *The hook or scissors may accidentally pierce the sclerotic.* This serious accident is fortunately rare, and is due to the exercise of undue force. It is most likely to happen when operating on a soft flaccid globe, which allows the sclera to be wrinkled under the pressure of the hook or scissors. With reference to this point, it is worthy of note that if it is desired to tenotomise a muscle at the same sitting as an operation is done on the interior of the eye, such, for example, as needling a lens in an eye with divergent strabismus, the tenotomy should be performed first, as there is a risk of the globe being in a flaccid condition after an operation that may involve loss of aqueous.

6. *Orbital Cellulitis and Suppuration.*—This is very rare, but we have known at least two cases, in one of which the eye had subsequently to be removed. It can only happen by the introduction of some septic material during the operation. As soon as the misfortune is evident, the conjunctiva should be laid freely open to allow of drainage, and warm fomentations applied. (See “Orbital Cellulitis.”)

Treatment of Strabismus after the Operation.—As a rule no local application is required for the eyes beyond frequently washing them with a little warm boracic lotion, to clear them from the slight conjunctival discharge which usually follows for a few days after the operation. If the eyes are hot or painful, a fold of lint wet with cold lotion may be laid over the closed lids, but a bandage is not required, as it is apt to increase the sense of heat, and to add to the discomfort of the patient. When the tendon of one eye only has been divided, the eye which has *not been operated on* should be covered with a single turn of a bandage twenty-four hours after the operation, so as to compel the patient to use the squinting eye, and thus to keep it in a central position until the divided tendon has acquired its new insertion. If there is much ecchymosis on the second or third day after the operation, the eye may be frequently washed with a little weak hazeline lotion (F. 45); or if there should be a muco-purulent discharge, a mild astringent lotion (F. 51) may be used three or four times daily.

OPERATION FOR THE ADVANCEMENT OF AN OCULAR MUSCLE.

Instruments.—Speculum (Fig. 130); fixation forceps (Fig. 132); Prince's forceps (Fig. 196) or strabismus hook (Fig. 194); straight blunt-pointed scissors (Fig. 193); three fine silk sutures; needle-holder.

Cocaine only is required, and its application will be needed from time to time during the operation. It is very undesirable to use a general anæsthetic, as the effects of the operation should be carefully estimated and adjusted before the patient leaves the operating table. Advancement is therefore an operation not suited to young children.

Many modifications of this operation have been suggested; but, in our opinion, none are better than Tweedy's* modification of the method originally devised by Critchett, of which the following is a summarised description:

"The operation as conducted for advancement of the internal rectus consists of ten stages, as follows:

"1. The lids being kept apart with a speculum, a fine silk thread is inserted into the conjunctiva and episcleral tissue, in a line with the horizontal diameter of the cornea, and about one-sixteenth of an inch from the inner margin of the cornea. The ends of the thread are left long with the needle attached (*see* Fig. 195). (The preliminary insertion of this thread marks, and afterwards indicates, the horizontal meridian of the eyeball, and still later serves as a suture for the middle of the rectus muscle.)

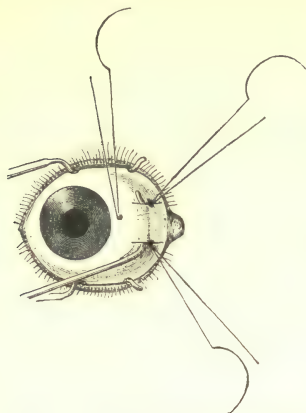


FIG. 195.—Tweedy's operation for advancement.

In the diagram the operation is being performed upon the internal rectus.

"2. Next a crescentic incision is made immediately to the nasal side of the thread and through the conjunctiva only.

"3. The conjunctiva is then gently detached from the underlying capsule towards the caruncle; but only far enough to expose the insertion of the rectus muscle, not to strip the muscle.

"4. A strabismus hook is then passed under the muscle.

"5. While the hook is in position, fine silk threads are attached to the upper and lower borders of the muscle and left long (*see* Fig. 195).

"6. The hold of the threads having been tested by gentle traction, the muscle is divided on the hook. (The operator is now

sure that he has secured the tendon.) The tendon may be held in Prince's forceps (Fig. 196) if preferred.

"7. The muscle is then carefully raised by means of the threads, and any remaining attachments of the muscle to the globe completely divided.

"8. The needle attached to the thread at the inner border of the cornea is passed through the middle of the divided muscle from within outwards, and in such a way as to penetrate the muscle and its sheath and overlying conjunctiva.

"9. The needles attached to the threads at the upper and lower borders of the muscle are now insinuated into the episcleral tissue, and made to emerge on the surface of the conjunctiva at about one-eighth of an inch from the upper and lower margins of the cornea respectively. This gives a broad and fan-like attachment to the muscle.

"10. The external rectus is now freely divided subconjunctivally,

* 'Lancet,' vol. lxxxiv, i, p. 512.

and then, while an assistant rotates the eyeball inwards, the corresponding ends of the three sutures are closely and firmly tied and cut short.

"Should shortening of the internal rectus muscle or removal of redundant conjunctiva be deemed necessary, it may be done just before the ninth stage. To ensure a complete and permanent result, there should be some convergence of the eye immediately after the operation, and no attempt should be made to exercise the muscle for a week afterwards."

Special attention should be paid to the following points:

a. The needles should be very sharp, as the episcleral tissue is tough, and there is a danger of using too much force and breaking the needle if at all blunt. We prefer a rather larger curve than that shown in Fig. 195, as less liable to break. The needle should be held by the needle-holder in the centre of the curve, and no leverage employed. A firm hold of the episcleral tissue is very important, and should be gauged by lifting the globe slightly with the needle, which cannot be done if the sclerotic is not entered.

b. The sutures should be finally adjusted as the patient's gaze is directed to some distant object, such as a small lamp affixed to the ceiling. The surgeon can then estimate the parallelism of the eyes, and tighten up or relax his sutures accordingly.

c. In advancement of the internal rectus for concomitant divergent squint the deviation should be slightly *over-corrected* (see page 417); but in advancement of the external rectus for concomitant convergent squint the deformity should be slightly *under-corrected*.

d. The ends of the sutures may be left long, and tied in a firm bow, so that re-adjustment is still possible the second or third day after the operation if thought desirable.

e. If everything is satisfactory, the sutures should be removed on the sixth or seventh day.

f. Both eyes should be bandaged for at least one week after the operation to ensure complete rest whilst the tendon is forming its new attachment.

Accidents that may happen during or after the operation:

a. The hook or scissors may pierce the sclerotic.

b. Orbital cellulitis and suppuration.

[Both of these rare complications have been discussed in dealing with "Tenotomy" (page 421).]

c. The needles may pierce too deeply, and completely penetrate the sclera. It is probable that this accident occurs with some frequency without the surgeon's knowledge; but it is very undesirable, and should

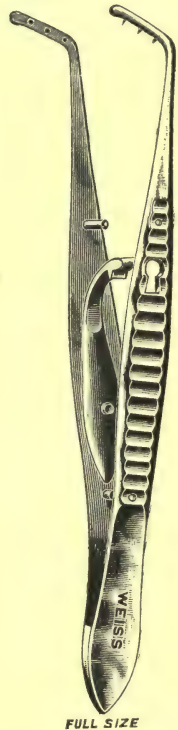


FIG. 196.—Prince's advancement forceps.

it be recognised the needle should certainly be at once withdrawn and re-introduced more superficially.

d. The needles may break into the sclera. To avoid this accident attention should be paid to the points just mentioned.

e. The sutures may prematurely give way. In this case the wound should be reopened, the tendon sought for, and advanced again with fresh care.

Capsular Advancement.—In this operation, first introduced by De Wecker, and since modified by Knapp, the muscle and its synovial sheath, derived from the capsule of Tenon, is advanced by *folding* the muscle on itself instead of actually dividing it. This is effected by sutures inserted in the same way as in the operation just described; and a certain amount of irritation is set up, by which a cicatricial bond of union is formed around the folded muscle. The operation presents no special advantage over advancement with division of the muscle, and the results obtained are not so good in strabismus of high degree.

HETEROPHORIA, OR SUPPRESSED SQUINT.

By heterophoria is meant a functional disturbance in the ocular muscles, especially in those associated for the reflex act of convergence and accommodation. Owing to faulty innervation, the muscular response to this reflex is in part either inadequate or excessive, with the result that binocular single vision is maintained with difficulty, and a train of subjective symptoms is called forth, indicative of muscle fatigue. Objectively, the condition is manifested by a *tendency* to deviation of the optic axes, which, inasmuch as binocular vision is still retained, is normally suppressed, and remains a tendency only, unless the interest for maintaining binocular vision is abolished, in which case a deviation of the optic axes at once becomes real and apparent. Hence heterophoria, a term introduced by Stevens, of New York, is also known as latent or suppressed squint, and is, as it were, an intermediate stage on the road to an actual strabismus. The latter may be the sequel in cases of latent divergence, where increasing myopia means increasing difficulty in preserving binocular vision; but in the large majority of cases this is not so, and the boundary line between a latent and an apparent squint is never crossed.

Heterophoria is classified, according to the direction towards which there is a tendency to deviation, into—

a. Esophoria (Stevens), or a tendency to undue convergence (latent convergence);

b. Exophoria (Stevens), or a tendency to undue divergence (latent divergence);

c. Hyperphoria (Stevens), or a tendency to vertical deviation, one eye being on a higher plane than the other.

To these must be added **Cyclophoria** (Stevens), or torsion of the globe, by which is meant a tendency to rotatory deviation round an antero-posterior axis. This condition is not well understood at present, and will be described apart from the other forms of heterophoria.

Latent, like apparent deviations are to be classified either as *paralytic* or *concomitant*, and the two varieties are distinguished in a similar manner to that employed in diagnosing a strabismus. Thus in paralytic heterophoria, the tendency to deviation will vary in degree according to the direction from which a given object is viewed, whereas when the heterophoria is concomitant, as it mostly is, it always remains of a constant degree, whatever be the position of the eyes.

Ætiology.—Refractive errors are in the vast majority of cases mainly responsible for heterophoria. In emmetropia the impulse for a given accommodative effort initiates a standard and proportionate convergence of the optic axes in order to maintain binocular single vision. In hypermetropia, in order to view any object clearly, an excess of accommodation is required proportionate to the amount of the error, but the same standard of convergence is needed as in emmetropia. In myopia, on the other hand, slight or, in many cases, *no* accommodative efforts at all are needed; but the eyes must converge as much, and often much more than in emmetropia. As a similar innervation stimulates both groups of muscles, it follows that there is always a tendency in hypermetropia to an excess of convergence, and in myopia to a relaxation. It must not, however, be thought that heterophoria follows as a natural sequel of abnormal refraction; for, in the first place, nature may in part remedy the difficulty by providing the hypermetrope with a specially powerful ciliary muscle and the myope with an abnormally weak one; so that a standard innervation which is usually productive of a standard degree of convergence is accompanied by increased ciliary contraction in the hypermetrope, and by an abnormally weak ciliary contraction in the myope. Further, many cases of refractive error acquire, up to a certain point, the power of dissociating their convergence and accommodation, and so of adapting themselves to their special needs.

The onset of heterophoria is indeed largely dependent upon the temperament of the individual, and though the liability increases with the refractive error, still even quite low grades of ametropia, especially when of an astigmatic nature, are subject to it, and as a rule patients with heterophoria are neurotic, and are often the subjects of other functional disturbances. Exception to this rule must be made in a certain number of cases when heterophoria comes on after an exhausting and debilitating illness, influenza being a common cause. In these the symptoms will often pass off as the nervous and muscular systems recover themselves, whereas the purely functional cases, as a rule, show little tendency to improve unless actively treated.

Symptoms.—These consist of aching eyes when working or reading, headaches, nausea, confusion of print, photophobia, and lacrymation. They closely resemble those produced by ciliary asthenopia from spasm or fatigue of the ciliary muscle, and, indeed, the two conditions are frequently associated, and can only be differentiated by the clinical tests to be described.

Tests for Heterophoria.—A good many tests have been described, but the following are ample for an accurate diagnosis:

1. Screen Test.—The patient is directed to fix his gaze at some object, such as a pencil, held in front of his eyes so that in order to see it without squinting he has to converge his visual axes. Whilst doing so the eyes are in turn covered, the object being constantly fixed meanwhile. If the convergence innervation is normal, both eyes will continue to fix the object, and no movement of either will take place as each in turn is covered or exposed; but if the innervation is faulty, the patient will unconsciously become aware as soon as one eye is covered that the necessity for binocular vision is abolished, and the covered eye will at once deviate behind the screen. On uncovering this eye a movement of re-adjustment will be necessary before this eye is able to fix the object, and the other eye, now screened, will in its turn deviate. This movement of re-adjustment as each eye is made to fix is much easier to recognise than the movement of deviation, which of course is in the opposite direction, and by it the surgeon recognises the extent and character of the heterophoria.

This test is diagnostic, but it does not form an accurate measure, and it has also the drawback that in deviations of slight degree, especially when vertical in direction, the movement of re-adjustment is so slight and rapid that it often escapes notice. A negative result must therefore not be considered final, and in all cases resort should be had to a much more delicate method of examination by Maddox's rods.

2. Test by Maddox's Rods.—This test is a greatly improved modification by Ernest Maddox of one originated by von Graefe, the principle of which is to dissociate the images of a single object as seen by each eye, so that they are perceived separately. The interest in maintaining binocular single vision being now abolished, the optic axes will, as in the screen test, deviate in one or other direction if heterophoria is present, and consequently the two images will hold an abnormal relation to each other, which is measured by means of prisms.

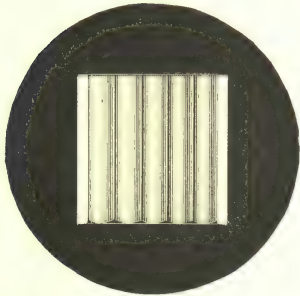


FIG. 197.—Maddox's rods.

To perform Maddox's test the room is darkened so as to concentrate attention upon a point of light, either a candle or a small lamp which is placed at a distance of five to six mètres from the patient, at which distance the optic axes are parallel. Before one eye in a trial-frame is placed a disc known as Maddox's rods (Fig. 197), which consists of a metal plate supporting a series of small glass cylinders, which should preferably be coloured red. One cylinder would suffice if accurately adjusted, but by having two or more the accurate apposition of a cylinder to the pupil of the eye is assured. In front of the other eye is placed a piece of green-tinted glass. The cylinder has the effect of drawing out any point of light into a line of light, the direction of which will lie at right angles to the long axis of the cylinder, so that if the rods are placed vertically a point of light will appear as a horizontal streak, and so on.

The vertical and horizontal muscles must be tested separately, and, for example, let us suppose that the horizontal muscles are to be first examined; for which purpose the Maddox disc is placed so that the long axes of the rods lie in a horizontal direction. The patient is now directed to look at the small light, and he will at once see two objects, a green light and, with the eye before which is placed the rods, which we will say to be the right eye, a *vertical* streak of red light. If there is perfect binocular vision, the two images will be exactly superimposed the one on the other, and the red streak will appear to lie directly in front of or behind the green flame (Fig. 198 [1]); but if there be the slightest deviation on the part of the lateral muscles, the streak will be correspondingly displaced to one or other side of the light. Thus if there be any latent divergence of the optic axes (**exophoria**), the streak will be displaced to the opposite side of the light (*crossed diplopia*), which in this case will be to the left (Fig. 198 [3]); whereas if there be undue convergence (**esophoria**), the streak will lie to the right of the flame (*homonymous diplopia*) (Fig. 198 [2]).

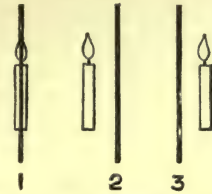


FIG. 198.—Maddox's test for lateral deviations. The rod is placed before the *right* eye.
1. Equilibrium. 2. Esophoria. 3. Exophoria.

The patient having informed the surgeon of the relative positions of the flame and streak, any deviation is measured in degrees, either by means of Maddox's lateral tangent scale (Fig. 199), which is marked off in prism dioptries, or by the strength of the prism which, placed before the right eye, causes superimposition of the images. Remembering that a prism always displaces an image in the direction of its apex (see "Prisms," page 397), the correcting prism must be placed base inwards in exophoria, and base outwards in esophoria. It is a good plan to place the prisms first one way and then the other, checking the patient's statements as to the deviation on the tangent scale by our own observations. Instead of putting in and taking out successive prisms from the trial-frame until the right one is found, an expeditious method is to use Riseley's rotary prism (Fig. 180), which consists of two strong prisms made to revolve in opposite directions by means of a small wheel; the varying strengths of the combined prisms being indicated by a scale.

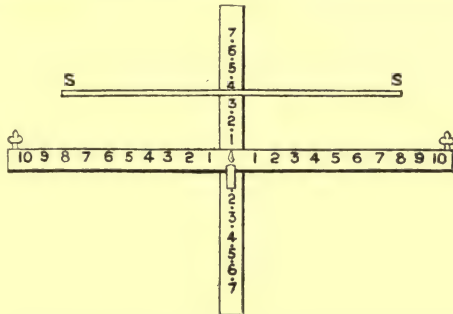


FIG. 199.—Maddox's tangent scale for measuring heterophoric deviations. Calculated for carrying out the test at 5 mètres. (After Maddox.)

In the centre is a small lamp, which forms the luminous object for the test. The numbers intersected by the streak in any case furnish the strength of the prism required to restore equilibrium. (ss) The streak of light here exhibits nearly four degrees of hyperphoria.

The vertical muscles are now tested in the same way, excepting that the rods are now placed vertically before the right eye, so that the

streak of light runs in a horizontal direction. If binocular single vision exists, the streak will exactly bisect the flame (Fig. 200 [1]); but if there is any tendency to vertical deviation (**hyperphoria**), the red streak will either lie above the flame, indicating that the right eye is on a lower level than its fellow (left hyperphoria), or below it if it is the right eye that is placed higher (right hyperphoria). The amount of deviation is measured with Maddox's vertical tangent scale (Fig. 199), or by means of prisms, which must be placed base downwards if the streak is displaced downwards, or base upwards if the streak lies above the flame.

To complete the diagnosis, the degree of deviation may be tested with the head turned in different directions, when if the deviation remains constant for all positions of the head, the heterophoria is of a concomitant nature, but if the deviation varies according to the direction from which the light is viewed, the heterophoria is paralytic. It is a good plan to employ the Maddox test both before and after correcting the refraction; excepting of course in myopia and other cases of low

visual acuity, when the correcting glasses must be worn before the test can be applied.

It is only to be expected, if a tendency to deviation can be made out for distant objects when the optic axes should normally be parallel, that such a tendency should increase as the object is approached and accommodation

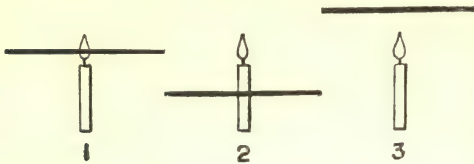


FIG. 200.—Maddox's test for vertical deviations. The rod is placed before the right eye.

1. Equilibrium. 2. Right hyperphoria.
3. Left hyperphoria.

and convergence are called more and more into play. Such an increase may, however, be regarded as more or less physiological, and practically if the faulty condition can be remedied when the eyes are nearly as possible in a condition of rest, it is found that such measures of treatment will suffice to maintain the proper relations of accommodation to convergence for near vision. Maddox has introduced a special method of employing his rod test for near objects, but for the above reason it need not be detailed, and the reader is referred for further information to his work on 'The Ocular Muscles.'

Maddox's test is a great improvement upon that originally devised by von Graefe, who caused vertical diplopia by a prism (6°) placed base down or up before one eye, when if there was any exophoria or esophoria, there would be lateral as well as vertical displacement of the images. Hyperphoria was not recognised when this test was introduced, and it further possesses the possibility of an error, because if the vertical prism deviates in the slightest degree from the perpendicular, there will in this way be caused some lateral separation of the images.

Before proceeding to treatment it will be well for the sake of clearness to summarise the chief points which characterise the various types of heterophoria.

Esophoria is the result of excessive convergence, and is most commonly associated with hypermetropia and hypermetropic astigma-

tism, in which an excess of accommodation is required over convergence. It is also more rarely encountered in low grades of myopia and myopic astigmatism, because these forms of refractive error may induce ciliary spasm, and with it a spasm of convergence. By Maddox's test with the rods horizontal homonymous diplopia is found, which is corrected by a prism placed base outwards, the strength of the prism being a measure of the degree of esophoria.

Exophoria, often known as "*insufficiency of the internal recti*," is a very frequent accompaniment of myopia and myopic astigmatism, especially in the higher grades, and is mainly due to the weak impulse to convergence called forth by the diminished need of accommodative effort in myopia, and which is insufficient to maintain the excessive convergence required in near vision. It is also sometimes found in high grades of hypermetropia when the accommodation breaks down owing to constant strain. In low degrees it is the most common of all types of heterophoria, and Maddox* has pointed out that in emmetropic eyes there always exists a tendency to divergence as an object is brought very close to the near point. With the Maddox rods placed horizontally crossed diplopia is found, which is measured as in esophoria, but requires the correcting prism to be placed base inwards.

Hyperphoria.—Vertical deviations are less easy to explain. It has been suggested that in a few cases they may be due to anatomical peculiarities in the attachment of the muscles; but in the vast majority they are closely bound up with refractive errors, and are occasionally associated with esophoria or exophoria. An explanation of this is probably to be found in the fact that convergence is not merely an associated contraction of the internal recti, but a much more complicated act, involving the innervation of several muscles, amongst which the superior and inferior recti are to be numbered.

In hyperphoria it is impossible, without testing the prism strengths of the opposing muscles, which not only takes much time but, like all subjective tests, is apt to lead to false conclusions, to tell whether we are dealing with a tendency to elevation of one eye or to depression of the other, and so for convenience it is customary to apply the term "*hyperphoria*" to the eye that under the Maddox test lies on the higher level, and thus to speak of a right or left hyperphoria.

It however occasionally happens that first one eye and then the other deviates upwards, so that when the Maddox rods are placed before each eye in turn, the streak always assumes the same position with regard to the flame. It is difficult to explain this anomaly, but it should make the surgeon careful to test both eyes with the rods. We have had one case of this nature under our own observation, and others have been recorded.

As a rule, hyperphoria even in low grades causes a great deal of subjective disturbance, much more than a corresponding degree of lateral heterophoria. This is probably due to the relative weakness of the vertical muscles compared with the lateral muscles; just as headache is so common, even in emmetropes, after a visit to picture galleries or after any other occasion which involves an unusual strain upon the

* 'The Ocular Muscles,' p. 341.

elevators of the eyes. Exceptions to this rule occasionally occur, and we have a patient who exhibits hyperphoria that requires a prism of 2° deviation for its correction, and who suffers no discomfort therefrom.

With the Maddox rods placed vertically, the streak is displaced above or below the flame, and the correction is measured by the strength of the prism placed base up or down which causes superimposition of the images.

Treatment of Heterophoria.—This may be considered under five main heads—(1) *Optical*; (2) *General*; (3) *Educational*; (4) *Prismatic*; (5) *Operative*.

1. **Optical.**—By this is meant the correction of the refraction. This is of the first importance, and it should be accurately and carefully done. A large number of cases get quite well by this method alone, because by wearing correcting glasses the relations of accommodation to convergence are properly re-adjusted. It applies with equal force both to vertical and lateral deviations.

2. **General.**—Attention to the general health is always indicated. A large number of cases of heterophoria occur in women who are the subjects of anæmia, menstrual disturbances, chronic dyspepsia, or various neuroses. Unless such disorders are successfully combated we must not look for a cure.

3. **Educational.**—This consists in the training and bracing up of the muscles by exercising them with prisms. It is a form of treatment that has found considerable favour with some surgeons; but we confess to disappointment, and have not as a rule found it of much service. It depends for success upon the theory that there is inherent *muscular* weakness in some direction, which is true in those cases which can be definitely proved to be of a paralytic nature, but which, in concomitant cases with *perfect conjugate movements*, is opposed to our knowledge of the origin of concomitant strabismus, and consequently of this its latent form. Thus in esophoria weakness of the abductors is assumed, and the exercise consists in placing a prism of four degrees deviation (the normal prism strength of the abductors) before one eye with its base inwards, and endeavouring to overcome the diplopia thus produced by an outward corrective squint. If the diplopia is insuperable at twenty feet, the patient approaches the object until the images can be fused, and then endeavours to maintain fusion for a minute or so until the eyes begin to ache. Each eye should be practised with the prism in turn, and every day attempts should be made to obtain fusion at a slightly longer distance from the object than the day before until the patient succeeds in overcoming the diplopia at twenty feet. The question that suggests itself is whether the weak abducting power found in esophoria is an inherent weakness, or only an apparent inability produced by spasm of convergence.

In exophoria a prism of twelve degrees deviation (the normal prism strength of the adductors) placed base outwards should be used, and the exercise carried out in the way just described. In vertical deviations a prism of one degree deviation placed base upwards before the higher eye and base downwards before the lower eye will be sufficient.

To obtain any lasting benefit these exercises must be carried out daily for a considerable period of time with intelligence and patience, and the glasses that correct the refraction should be worn.

4. **Prismatic.**—If the symptoms are not relieved by the measures above mentioned, we must resort to prisms as a means of palliating them. Rather less than the full strength required to correct the deviation under Maddox's test at twenty feet should be ordered, and it should be halved between the two eyes. For example, supposing the correcting prism be one of three degrees deviation, a prism of one degree deviation should be ordered for each eye, base inwards if the condition be one of exophoria, base outwards if one of esophoria, and in vertical deviations base downwards before the hyperphoric eye and base upwards before the lower one. These prisms should be prescribed to be ground on to the glasses correcting the refraction, and should be worn for close work. It is rarely necessary to order prisms for distant vision, and it is very unwise to do so unless necessity compels, as it engenders a wish for further aid and an increasing strength of prism, a result that is undesirable, not only because it shows that the patient is actually deteriorating under the treatment, but also because it is only possible to wear prisms of moderate degree with comfort.

5. **Operative.**—This consists in esophoria of tenotomising the interni, or advancement of the externi; in exophoria chiefly of advancement of the interni; and in hyperphoria of either advancement or tenotomy of the vertical muscles as is deemed advisable. Such methods of treatment should be reserved for the few cases in which failure has attended prolonged efforts in the other directions above described, and they should be carried out with the greatest care and discretion on account of the danger of producing an absolute strabismus or very troublesome diplopia. Of recent years Stevens, of New York, has introduced a system of *partial* tenotomies effected by a special set of delicate instruments which he has devised for the purpose. A limited number of the tendon fibres are divided at a sitting; first the middle ones (Hansell and Reber), and then the marginal fibres until the desired effect is reached, gauging the progress towards equilibrium by frequent interruptions for examination with Maddox's rods or other tests. In several cases two or three such partial tenotomies appear to be required. This method has been greatly advocated in America, and is extensively practised there with good results, but it has so far not obtained favour in this country, and we cannot speak of it from experience.

Cyclophoria, or Torsion.—As already mentioned on page 424, this indicates a tendency to rotation of the globe round its antero-posterior axis. Savage,* of Nashville, ascribes it to an insufficiency of the oblique muscles. The condition is easily recognised by Maddox's test when, if the rods are placed horizontally before the eye, the red streak, instead of being vertical, is tilted to the right or left. As the projection of an image is always in the opposite direction to the deviation, so tilting of the streak to the right indicates that the eye is rotated to the left, and con-

* 'Ophth. Rec.,' Chicago, vol. viii, 1899, p. 32.

versely. It is, however, to be borne in mind that tilting of the streak can be obtained in all cases by tilting the head to one or other side, so that this element of confusion must be carefully eliminated if a patient at first appears to present this curious deviation. A rough measure of the torsion is the number of degrees of a right angle as marked on an ordinary trial-frame, through which the rods must be passed in order to bring the streak to the perpendicular.

Treatment.—So little is known of this condition and of its exact ætiology that not much can be said on this point. It is conceivable that in a certain number of cases the rotation may be the resultant of two forces exercising traction in different directions, as when hyperphoria is present with esophoria or exophoria; and the refraction should, as in other forms of heterophoria, be carefully examined and corrected. Savage advises the exercise of the weak oblique muscles with concave cylinders, for the details of which the reader is referred to the author's description.

NYSTAGMUS.

Nystagmus, or involuntary rhythmic oscillations of the globe, is primarily a nervous condition, consisting of a faulty co-ordination of the ocular muscles, whereby the patient is unable to perform the act of fixation.

The disease is readily divided into two classes: (1) cases which appear in early infancy, and can generally be classed as **congenital**; and (2) **acquired** nystagmus, which is either a local symptom of organic disease of the nervous system, or is the direct result of the patient's occupation. To these two classes must be added a few cases in which the nystagmus is **voluntary**, that is, under the patient's control.

CONGENITAL NYSTAGMUS.—The most common cause is a failure to learn to co-ordinate the eyes for fixation in early infancy on account of defective visual acuity; and so congenital nystagmus is a frequent defect in microphthalmos, congenital optic atrophy, albinism, congenital cataract, and in eyes partially lost or destroyed by ophthalmia neonatorum. Eyes that are rendered defective or lost in after life when co-ordination has been fully established never exhibit nystagmus. The oscillations, which are uncontrollable and occur without the patient's knowledge, are generally bilateral and equal on both sides,—that is to say, the optic axes maintain their parallelism. Loss of parallelism may, however, occur (*see* "Spasmus Nutans," page 389), and occasionally one eye only is affected. The oscillations are continuous, being arrested only in sleep; but many cases exhibit variations in the degree and rapidity of the excursions, which become more violent when the eyes are turned in certain directions, or when special efforts are made at fixation. In direction they are most commonly horizontal, but occasionally they are purely vertical or rotatory, and sometimes a combination of rotation with vertical or horizontal motion is observed. The oscillations do not

interfere with the performance of conjugate movements, which are free and normal in range.

Defective vision is not, however, accountable for all cases of congenital nystagmus. The peculiar transient affection of infancy known as spasmus nutans is always accompanied by nystagmus (*see* page 389), and a few cases have been recorded in which there has existed a family predisposition to nystagmus which is transmitted through the females to the males, as in hæmophilia and pseudo-hypertrophic paralysis. Lloyd Owen* and McGillivray† have published two such cases, and recently we have had our attention drawn to a family in which nystagmus was present in the mother's brother, and was reproduced in the two nephews, whereas the only niece escaped.

Treatment.—The only treatment likely to benefit is, if possible, to improve the sight, and this is one of the strongest reasons in favour of an early operation for congenital cataract in those cases in which the opacity of the lens is sufficient to prevent the child from discerning objects. Even though nystagmus does not appear during the first few months, it is very likely to do so when the intelligence begins to be awakened, and the good effects of an operation will be then diminished.

ACQUIRED NYSTAGMUS.—The great clinical difference between acquired and congenital nystagmus is that in the acquired variety the patient is always cognizant of the defect, objects appearing to dance before the sight, and producing in many cases symptoms of nausea and vertigo.

a. From Disease of the Nervous System.—In disseminated sclerosis nystagmus is often one of the earliest signs of inco-ordination. It is also fairly common in cerebellar disease and in Friedreich's ataxia. In posterior basic meningitis it is one of the clinical signs which, taken with the absence of optic neuritis, helps to differentiate this disease from tubercular meningitis. (*See also* "Diseases of the Nervous System," page 389.)

b. From Occupation.—The most frequent example of this is known as **Miners' Nystagmus**. It is a form of rotatory, or a combination of rotatory and lateral nystagmus that occurs amongst miners working in coal-pits, and a good deal of controversy has been waged as to its causation. Snell, of Sheffield, with very large experience, has concluded that the principal cause is the oblique upward position into which the miner's eyes are thrown whilst lying in a recumbent position engaged in cutting out the coal, or holing, as it is technically called. On the other hand, Court, of Staveley, also with large experience, is of opinion that the prime factor is the very defective light afforded by the safety-lamp, and he found that miners working in naked-light mines, where the illumination is much stronger, rarely suffer from the affection.

Much can be said for Snell's view, the more especially as he has drawn attention to the fact that several other trades in which *special* strain is thrown upon the elevators of the eyes may occasionally exhibit nystagmus. In a total of nineteen cases recorded, twelve trades

* 'Ophthalmic Rev.,' 1882.

† *Idem*, 1895.

are included, and six, or nearly one third, occurred in compositors.* On the other hand, it must fairly be urged that defective light must add considerably to any strain thrown upon the eyes by an unnatural position of the head; and whilst the latter is with little doubt the chief agent in determining the nystagmus, the deficiency of light may be the reason why nystagmus occurs with so much greater frequency in miners than in other trades also involving a strain upon the elevators. Night-blindness (nyctalopia) and photophobia are also frequently associated with miners' nystagmus. It comes on without warning, and is generally very persistent, though some cases do recover under the influence of strychnine if removed from the pits.

VOLUNTARY NYSTAGMUS, or the power of inducing nystagmus at will, is rare. The following are two examples,† and we have occasionally encountered others :

CASE 1.—A gentleman told us that he possessed the power of shaking both his eyes, and that he had been able all his life to shake them at will. At our request he gave us a performance. First making both his eyes steady, he then set both into rapid lateral motion, so rapid that the outline of the corneæ was completely lost to view. The movements were really an exaggeration of what is seen in horizontal nystagmus, but they were so rapid that the margins of the corneæ could not be defined.

CASE 2.—A former house surgeon in the Royal London Ophthalmic Hospital possessed the power of voluntary nystagmus, but the lateral movements of his eyes were not nearly so rapid as in the case above related. Before setting his eyes in lateral motion, he had to converge them sufficiently to squint, and then he could simulate horizontal nystagmus. The movements were completely under his control, and could be started and arrested in a moment.

* 'Trans. Ophth. Soc. U. K.,' vol. xvi, 1896, p. 305.

† 'Roy. Lond. Ophth. Hosp. Rep.,' vol. x, p. 203.

CHAPTER XXV.

DISEASES OF THE LACRYMAL APPARATUS.

ANATOMY.—The lacrymal apparatus consists of two main portions :

1. The lacrymal gland or secretory portion.

2. The lacrymal canal or excretory portion.

1. **The lacrymal gland** lies in a depression situated in the external angle of the orbital plate of the frontal bone, and consists of two lobes—an upper, which is much the larger, and a lower or accessory gland, which lies directly beneath the upper, and is in close relation with the conjunctival fornix of the upper lid. Between the two, but not entirely dividing them, is the outer portion of the tendinous expansion of the levator palpebræ superioris.

2. **The lacrymal canal** is conveniently divided up into three parts : (1) the canaliculi ; (2) the lacrymal sac, and (3) the nasal duct—the latter two together forming the lacrymal canal.

The canaliculi are two small canals in the free borders of the upper and lower lids respectively, forming the vertical boundaries of the small triangular space near the inner canthus known as the "*lacus lacrymalis*" (see also "*Conjunctiva*"). Each canaliculus commences by a slightly elevated orifice called the "*punctum lacrymale*," which looks directly towards, and is applied to the conjunctiva of the globe. Each canaliculus is shaped something like a tobacco pipe, the short arm or bowl corresponding to the commencement of the duct, which is directed vertically, whilst the long arm or stem passes nearly horizontally to the inner canthus, slightly converging towards its fellow, and opening with it, usually by a short common trunk, into the lacrymal sac.

The lacrymal sac is a membranous bag situated in a depression on the lacrymal bone. The tendo oculi passes in front of it, and externally and behind it is enwrapped by specialised fibres of the orbicularis muscle known as "*Horner's muscle*." It measures in its long vertical diameter about $\frac{1}{2}$ inch, and it is capable of great distension. Its blind summit reaches well above the level of the tendo oculi, whilst inferiorly it opens by a somewhat constricted orifice into the nasal duct.

The *nasal duct* is a bony canal formed by the lacrymal and inferior turbinated bones internally, and by the nasal process of the superior maxilla externally. It is usually about $\frac{3}{4}$ inch in length, and opens below by an oblique slit-like orifice into the inferior meatus of the nose. Both sac and duct are lined by a common mucous membrane, which in the nasal duct is separated from the periosteum by a considerable plexus of veins. The diameter of the nasal duct in the cadaver



FIG. 201.—The lacrymal apparatus. (After Schwalbe.) (A) Superior portion of the lacrymal gland. (B) Its inferior portion. (D) Lacrymal ducts. (E) The upper eyelid partially diverted of skin. (P P) Upper and lower puncta. (C C) The canaliculi, which in this case unite before entering. (S) The lacrymal sac. (N) The nasal duct.

varies from 3 to 4 mm., and its direction from above is downwards with a slight inclination outwards and backwards. The whole length of the lacrymal canal from the opening of the inferior canaliculus into the sac is just over one inch.

The tears consist of water with a slight admixture of sodium chloride. Normally, except under the influence of emotion, the secretion is only just sufficient to serve for lubricating purposes, and it must not therefore be thought that tears are constantly dripping into the nose. The exact method of excretion is not altogether certain. The act of winking combined with the move-

ments of the globe serve to carry the tears across to the inner side, whence for their further removal the correct adaptation of the puncta to the conjunctiva of the globe is indispensable. It is generally thought that the entry of the tears into the canaliculi is facilitated by compression of the sac between Horner's muscle and the tendo oculi, with resultant slight suction action; but in any case the process is a slow one, and if tears are being secreted in any quantity, they normally overflow on to the cheek.

CONGENITAL ABNORMALITIES.—These are mostly rare and unimportant. Defects may occur in the canaliculi, which may be rudimentary or even absent; and in the punctum, which may not be patent, or may be represented in duplicate. Congenital stricture of the nasal duct is not very uncommon, and one or two cases have been reported of congenital fistula of the lacrymal sac.

LACRYMATION AND EPIPHORA.—These are two terms, both expressive of an overflow of the tears, but used in a widely different sense.

Lacrymation indicates an actual hypersecretion of tears, which escape on to the cheek, owing to the rapidity with which they are secreted. It is called forth in a large variety of conditions both of the nose and eye, and as regards the latter, it is a common symptom in

affections of the cornea, and, in a less marked degree, accompanies inflammations of the conjunctiva, iris, and ciliary body.

Epiphora, on the other hand, expresses an overflow of tears caused by some imperfection in the lacrymal apparatus, through which the escape of the tears is retarded. They consequently accumulate in the lacus at the inner angle of the eye, and from time to time flow over the margins of the lid on to the cheek. The exposure of the eye to cold or wind aggravates the epiphora by stimulating the lacrymal gland to an increased secretion of tears. Epiphora may arise—

1. *From a displacement of the punctum without any mechanical obstruction in the canaliculus, lacrymal sac, or nasal duct.*

a. In old people a relaxed orbicularis frequently allows the lower lid to fall from the globe, and to become slightly everted, thus drawing away the punctum from its proper position with respect to the globe.

b. A similar result is seen in lippitudo, p. 457, and in all cases of ectropion of the lower lid.

c. Inversion of the punctum from entropion of the lower lid.

2. *Obstruction of the canaliculus.*

a. From closure of its opening into the sac.

b. From some foreign body (frequently an eyelash), or from a small chalky concretion.

c. From a tarsal cyst or styne pressing upon the canaliculus.

d. From a wound of the lid involving the canaliculus.

3. *Obstruction in the lacrymal sac or nasal duct.*

a. From acute inflammation of the sac.

b. From blennorrhœa or chronic inflammation of the sac.

c. From stricture.

d. From mechanical obstruction by tumours.

Treatment.—The treatment of lacrymation as a symptom of eye disease is intimately merged in the treatment of the primary affection of the cornea, etc., and has already been discussed.

In the same way, epiphora is only to be regarded as a symptom of a primary derangement in some part of the lacrymal apparatus, the site and nature of which must be discovered in order to successfully deal with the epiphora.

Foreign bodies or concretions in the canaliculus should be extracted. Sometimes this can be accomplished with the aid of a pair of iris forceps without any cutting operation; but if not, the canaliculus must be laid open, when all difficulty will be removed. The treatment of the other causes of epiphora which have been mentioned will be found under their respective headings.

MALPOSITION AND OCCLUSION OF THE PUNCTUM.—Displacement of the lower punctum causes considerably more epiphora than is the case with the upper, on account of the gravitation of the tears to the lower conjunctival sac. The slightest eversion of the lid is sufficient to draw away the punctum so that it fails to receive the tears. Inversion may likewise cause epiphora, but not to a corresponding degree, unless severe. Epiphora from displaced punctum is one of the commonest of

maladies, especially in old people, in whom the deformity is produced by simple relaxation of tissues.

When the punctum has been long everted, and especially when such eversion is caused by inflammatory conditions of the lid, it frequently becomes constricted, and sometimes so completely occluded that it is difficult to recognise any trace of its presence.

Treatment.—When the eversion is slight it is often possible to bring the punctum back to its normal position by touching the conjunctival surface of the lid around the punctum with lunar caustic, in order to produce a small cicatrix, which drags on the punctum and inverts it again. The application is not painful if a few crystals of cocaine are first laid over the part. Two or three applications of caustic may be required at intervals of a few days. The punctum should, at the first sitting, be dilated, and the canaliculus syringed through in the manner described on page 441, to make sure that no mechanical obstruction exists to the passage of tears.

Severer degrees of displacement require the opening of the canaliculus, which should be performed as described on page 442; excepting only that a better result is obtained if the canaliculus is not opened up into the sac, but only just far enough to place the new gutter in a favourable position for the reception of the tears. In still more severe displacements other measures, in addition, will have to be taken with regard to the lid itself before relief will be obtained. When the punctum is completely occluded, so that the canaliculus cannot be slit up in the ordinary way, the opening must be effected by making a small incision along the line of the canaliculus, which is thus opened from above (*see also* under “Senile Ectropion”).

INFLAMMATION OF THE LACRYMAL SAC—DACRYO-CYSTITIS.

ACUTE INFLAMMATION OF THE LACRYMAL SAC usually attacks only one lacrymal sac, although we have seen both involved at the same time.

Ætiology.—This is sometimes obscure. Most usually it occurs as an acute congestion following a chronic stricture of some part of the lacrymal canal, and there is often a history of long-standing epiphora. In other cases it is caused by a periostitis of syphilitic or tubercular origin. It is said to occasionally follow an attack of acute purulent conjunctivitis as an extension of the inflammation along the canaliculi, but such a method of origin is very uncommon.

The symptoms are most acute—pain, heat, redness, and swelling over the sac, extending to both the upper and lower eyelids, which are frequently so œdematous as to be closed over the eye. The pain is often excessive, the slightest pressure with the finger on the sac being almost intolerable. These symptoms continue to increase, when suddenly the patient experiences a sense of relief. The inflamed sac distended with pus has given way, and the discharge has escaped into the cellular tissue between the skin and the membranous sac. A superficial abscess is now formed, and the pus gradually makes its way to the surface, and points a little below the tendo oculi.

If the disease be allowed to progress untreated, the purulent contents of the sac are discharged through the ulcerated opening on the face, the inflammation subsides, and the parts slowly regain their normal appearance; but frequently a fistula remains at the site of the wound which communicates directly with the sac, and through which there is a constant flow of tears on to the cheek.

The early symptoms of acute inflammation of the sac may closely resemble those of a severe attack of catarrhal ophthalmia, as they are often associated with a muco-purulent discharge from the eye; but in all cases of doubt the pressure of the finger over the lacrymal sac will, by the pain it produces, at once remove all uncertainty.

Diagnosis.—This is usually quite straightforward. The site of the swelling, the presence of epiphora, and the history are characteristic. A superficial abscess may, rarely, cause confusion; but there will be little or no epiphora. From acute distension of the frontal sinus, it will be distinguished by the signs already given, and by the site of chief swelling, which is below the tendo oculi.

Treatment.—During the acute stage, when pus is forming, fomentations of hot boracic lotion or of decoction of poppy heads should be frequently used. As soon as there is reason to believe that the sac is distended with pus, an external opening should be made to give vent to it. An ordinary scalpel or Beer's knife should be made to enter the membranous sac a little below the tendo oculi, and as the blade is withdrawn the incision should be carried downwards and outwards through the skin and deep tissues to the extent of about half an inch. A small strip of lint or gauze is then to be placed in the wound to prevent its edges uniting, and fomentations re-applied. In three or four days' time, when all the swelling has subsided, the canaliculus should be slit up in the manner described on page 442, and a lacrymal probe (Fig. 207) passed into the sac. If any stricture is detected, probes ought to be passed twice a week for a short time (see "Treatment of Stricture," page 443). If after a fortnight or three weeks a muco-purulent discharge should continue, the sac must be washed out with an astringent lotion, such as the Lotio Zinci Sulph. (F. 55), and this irrigation should be repeated daily until all discharge ceases.



FIG. 202.—A case of enormous distension of the lacrymal sac with muco-pus. The position of the swelling below the line of the tendo oculi is well shown.

CHRONIC INFLAMMATION OF THE LACRYMAL SAC—BLENNORRHŒA OF THE SAC—MUCOCELE.—This is a disease of slow progress and long duration. The patient generally is unable to say when it commenced, so long has he suffered from epiphora; but an increase in the

severity of the symptoms has induced him to seek advice. This is the tale of a large number of such cases.

Ætiology and Pathology.—In a very large majority of cases mucocoele is associated with a stricture of some portion of the lacrymal canal. In such, the stricture is very often the starting-point of the blennorrhœa; but inasmuch as mucocoele sometimes exists without any stricture, it is probable that in a certain number of cases the obstruction is the result of the mucocoele and not its cause. In either case the stricture, once established, becomes the chief agent in maintaining the blennorrhœa by favouring the retention and decomposition of the secretions, and for this reason the removal of such obstruction becomes a matter of the first importance.

The causes of stricture are numerous.

1. *Ulceration* of the mucous lining of a catarrhal, syphilitic, or tubercular origin, occurring at any part, but particularly at those points where the canal is somewhat constricted, and so most commonly found at one of three places, of which the first two are the most frequent sites.

a. At the spot where the canaliculi enter the sac.

b. At the line of junction of the lacrymal sac with the nasal duct.

c. At the opening of the nasal duct into the nose.

2. *Caries* of the bony canal, usually due to syphilis or tubercle.

3. *Trauma*. The passage may be obliterated by fracture of the bony walls, or a traumatic stricture may be initiated by violent and injudicious probing.

4. *Tumours* growing from the antrum, nasal fossæ, or base of the skull may occlude the canal.

5. *Chronic inflammatory conditions of the nasal fossæ*, which are especially liable to affect the opening of the duct into the inferior meatus.

6. *Congenital malformation of the duct*.

In old people mucocoele is not infrequently found unassociated with stricture, and is then most commonly due to senile atony of the sac, whereby it becomes gradually distended with secretions of which it is unable to rid itself, and which consequently

decompose. In young children, too, a simple blennorrhœa without stricture is not uncommon, and may arise without apparent cause. Attempts have been made to trace these cases to an antecedent purulent conjunctivitis; but it is very doubtful if mucocoele ever arises in this way, and putting the converse proposition, it is certain that a mucocoele may discharge into the conjunctival sac for years without creating any conjunctival irritation.

A good deal of interest attaches to the epiphora occurring in lacrymal obstruction. Bock, Stanculéanu, and Théohari have lately pointed out that changes occur in the lacrymal gland in cases of chronic



FIG. 203.—Lang's punctum dilator.

lacrymation or epiphora, and their researches seem to show that a reflex irritation of the gland, causing hypersecretion, takes some direct part in the production of epiphora in mucocele, which is therefore not entirely the result of mechanical obstruction. This theory also accounts for the improvement in the epiphora that follows excision of the diseased lacrymal sac, which serves as a source of irritation. A further reference to this matter will be found on page 446. The well-known connection between the nasal and lacrymal nerves, as evinced in the reflexes of sneezing and lacrymation upon sudden exposure to bright light, and conversely, the lacrymation which always accompanies nasal catarrh, are analogous examples, and help to explain a reflex gland change in mucocele.

Symptoms.—Constant epiphora. The finger placed over the membranous portion of the sac will detect a fulness, sometimes amounting to an absolute protuberance, and a moderate pressure on this will cause a regurgitation of thick viscid mucus or muco-purulent secretion through one or both puncta. The degree of distension of the sac varies with the duration and severity of the disease. In some cases there is a mere thickening and dilatation of the upper extremity of the sac which may be felt with the finger just below the tendo oculi; whilst in severe and long-standing cases the sac is so enlarged as to be expanded along the border of the orbit, and to appear as a tumour the size of a bean, corresponding in position to the inner half of the lower lid.

Owing to the constant exudation from the canaliculi, the eye is apt to become irritable, the caruncle red, and the edges of the lid excoriated. The sight is also frequently dimmed from films of mucus floating in the tears across the cornea, and the patient is troubled by having repeatedly to wipe away the accumulated tears from the inner angle of the eye.

Treatment.—The first course to be pursued is to determine the patency of the lacrymal canal by testing its freedom to the passage of fluids. The lower punctum is dilated by means of Lang's dilator (Fig. 203) and the lacrymal syringe (Fig. 204), filled with some weak astringent solution, is passed along the canaliculus into the sac. If the cannula passes easily into the sac and on pressing the piston the fluid passes readily into the nose, as shown by coughing and convulsive efforts to swallow on the part of the patient, and by the absence of regurgitation of the fluid backwards along the canaliculus, we may hope to cure the mucocele without operative measures by means of astringent lotions and daily astringent irrigations of the sac. Lotions of alum, resorcin, or zinc (F. F. 39, 51, 54, 55) are efficacious for this purpose, and the patient should be instructed to frequently empty the sac by pressing it against the nose with his finger. If, on the other hand, definite obstruction is found to the ready passage of fluids, or if



FIG. 204.—Lang's lacrymal syringe.

the case does not improve after fair trial by syringing and the use of lotions, the next procedure must be to open the canaliculus to determine the site and nature of the obstruction or allow of freer drainage. The lower canaliculus is the one usually chosen for incision, as being more convenient for subsequent probings, unless, as sometimes happens, the mucocele discharges wholly through the upper canaliculus, in which case the latter is to be preferred.

To open the lower canaliculus, the best method is as follows:—The surgeon stands behind the patient, who is seated on a chair with his head thrown rather back, and uses his right hand for the patient's right eye and his left for the patient's left eye. With the thumb of the disengaged hand he gently puts the lower lid on the stretch, and at the same time draws it outwards so as to make the parts tense. Having first sufficiently dilated the punctum with Lang's dilator, a Stillings' or a Tweedy's knife (Figs. 205, 206) is passed along the canaliculus until the tip is felt to impinge against the nose, when, by slightly raising the hand and giving to the blade a slight cutting movement, the latter is made to divide the canaliculus throughout its extent.

The operation is a simple one, and can be made practically painless by first placing a few crystals of cocaine along the edge of the lid; but there are one or two points which require attention.

1. In making the section care must be taken that the edge of the knife points upwards and slightly inwards, so that the gutter made by the section opens towards the eye, and is thus adapted for the reception of the tears. If the section has any outward inclination, it will defeat this object.

2. If there be a stricture at the entrance of the canaliculus into the sac, it is often difficult to effect an entry into the sac, which is pushed before and not pierced by the knife. This difficulty may be usually overcome by a few slight sawing movements, combined with steady pressure against the wall of

the sac; but if this is unsuccessful, the best plan is to complete the section with a sharp-pointed knife such as Beer's knife (Fig. 228).

3. The lips of the wound will very speedily unite unless kept apart for the first few days by daily passing a probe along the wound.

The sac having been opened, the nasal duct is next explored by a lacrymal probe. Several different varieties of probes have been introduced, and all have their several advocates. Personally we have always found Couper's bulbous-pointed probes (Fig. 207) very efficient, and invariably employ them. A medium-sized probe (No. 3) should be tried first, and if no passage can be found, successively smaller ones should be employed.

A lacrymal probe should be introduced in the following way:—The position of the operator, etc., are the same as recommended for opening the canaliculus. Probing is painful, sometimes exceedingly so, and the pain is quickest alleviated by coating the probe with a



FIG. 205.—Stillings' canaliculus knife.

good layer of 2 per cent. cocaine ointment, which also aids its passage. The probe, held horizontally between the forefinger and thumb, is passed along the divided canaliculus till its end strikes the nose, when, keeping the point of the probe as a pivot, a sweeping upward movement is made, by which the probe is carried into a vertical position for its passage down the duct. At this point the probe not infrequently slips out of the sac, an accident that will be discovered at once by the wrinkling and dragging of the lid which takes place as soon as any downward pressure is exercised. In passing the probe down the duct its direction (*see* "Anatomy," page 436) should be borne in mind. There is a tendency with the inexperienced to pass it too much backwards, a mistake that can be avoided by keeping the probe always against the patient's brow. The amount of force that it is justifiable to use must depend upon the knowledge and experience of the surgeon, but it is to be remembered that not only are false passages readily made, and the probe passed into the orbit, or antrum, or pharynx, all of which accidents we have known to occur; but also, short of perforation of the bone, much injury may be done by the laceration of the mucous lining of the canal, and a traumatic stricture thus added to the original one.

Having in this way found a probe that will pass into the duct, it is a good plan to rapidly dilate the stricture by the passage of successively larger probes until Couper's No. 4 has been introduced, beyond which it is not necessary to go.

The free drainage of the sac and the dilatation of the stricture must henceforth be maintained until all discharge has disappeared and the stricture has ceased to re-contract. Probing should at first be carried out twice weekly, and the intervals gradually extended as the case improves. Some surgeons advocate the dilatation of the stricture to a much greater extent than that recommended, and it is surprising what a large instrument the nasal duct is capable of accommodating. Nevertheless the object in probing is not to make the nasal duct as large as possible, but to render it as nearly normal as possible, and the maximum calibre of the duct in the cadaver is far from being the normal condition in life when a thick vascular pad lines its walls (*see also* "Anatomy," page 436). Large probes secure an abnormal patency by the compression and alteration of this mucous lining; they cause an unnecessary increase of pain without compensating advantage; they frequently produce laceration with much bleeding and subsequent inflammatory congestion, and thus partly defeat their own object; and lastly, their use necessitates an abnormally large opening into the sac and meatus of the nose, which is a source of inconvenience and distress to the patient by causing a regurgitation of air up the nasal duct every time he blows his nose.



FIG. 206.—Tweedy's canaliculus knife.

Some strictures bleed very easily and profusely, and in these the manipulations should be more than usually gentle. We may be sure that if much bleeding occurs, no benefit will follow the probing, but rather harm; for it implies a breach of surface, consequent delay in the cure, and the possibility of adding a traumatic stricture to the original one. Bleeding, therefore, should be an indication for less frequent and more gentle probings.

If much congestion follows a probing, this should always be allowed to quiet down before probes are passed again.

In a certain number of cases the stricture is so tight that the smallest instrument cannot be introduced. If the obstruction is not bony, the stricture may then be divided by passing a Stilling's knife into the duct and, by a few vertical sawing movements, making a free passage; after which a good-sized style should be introduced and worn continuously until the wound has healed. Many forms of style have been introduced, but nothing is better than a piece of thick lead or silver wire of the gauges 16 to 18; and if the distal end be neatly rounded off with a file, it is easy to introduce, and causes little or no discomfort. The wire should be cut to such a length that its distal end may rest upon the floor of the nose whilst the upper extremity is bent well over the lid, so as to form a hook. By this means the style is prevented from slipping into the sac, an accident which has frequently happened when due precautions have not been taken. Should a style slip into the sac, and it cannot be withdrawn through the aperture by which it was introduced, the latter must be enlarged, or, if necessary, the lacrymal sac must be laid open externally and the style removed by a pair of forceps.

After the style has been worn for ten days to a fortnight, it should be removed, and probings at regular intervals undertaken as above described. Impermeable bony strictures cannot be treated in this way. Drilling an opening into the nose is not very satisfactory, on account of the persistent tendency of the opening to close as soon as probings are discontinued. The best method is to excise the lacrymal sac as described below, by which the discharge is removed and the epiphora usually sensibly decreased.

If after a trial of some months with antiseptic irrigations and probings the symptoms are not relieved, as sometimes happens, especially in cases of a tubercular nature, the best treatment is to remove the lacrymal sac. This can be done by means of free scraping and caustics or by excision. The latter method is the one usually employed, on account of the well-known difficulty that appertains to

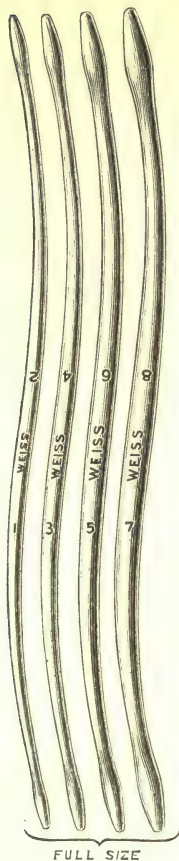


FIG. 207.—Couper's lacrymal probes.

the obliteration of a mucous canal. Excision of the sac is not easy, and its removal *must* be thorough, for if any part is left behind the patient will receive no benefit.

Removal of the Lacrymal Sac.—There are two ways of extirpation. By one method a dissection is carried out, and the sac taken away without opening its cavity. By the other the sac is opened in the first incision, the advantage in this method being the more easy recognition of the walls and limitations of the sac. In either case the upper limit of the incision is placed immediately below the inner palpebral ligament, and is thence carried straight downwards for three quarters of an inch along a line joining the inner canthus of the eye to the canine tooth. If the sac is to be opened by the first incision, the knife, with its edge pointing downwards along this line, is thrust straight backwards beneath the *tendo oculi*. As soon as the knife strikes the bone the handle is depressed towards the forehead and the knife made to cut its way out, enlarging the incision throughout its depth to the required length as it does so. The attachments of the sac are very firm, and must be separated by forceps or a small raspatory. The opening into the sac will be recognised by passing a probe through the canaliculus. There is always considerable bleeding, which makes the operation tedious and difficult. The wound usually heals without trouble, and if the extirpation has been thorough, the results are decidedly satisfactory, both as regards relief from discharge and in diminution of epiphora, as above explained.

In a few cases, however, epiphora still continues in sufficient quantity to cause great inconvenience, and it is then permissible to remove the lacrymal gland or part of it in the manner described on page 449.

FISTULA OF THE LACRYMAL SAC is one of the results which occasionally follow acute inflammation and abscess of the sac. A small sinuous track exists between the sac and the integument, through which a discharge oozes on to the cheek. We have also seen a lacrymal fistula remain after the patient has given up the wearing of the old-fashioned style, which was introduced by an opening made in the sac through the skin just below the *tendo oculi*. Lacrymal fistula is occasionally associated with necrosis or caries of the bones forming the lacrymal canal, and very rarely it is a congenital deformity.

Treatment.—In all fistulæ connected with mucous canals the course to be pursued is first to cure the stricture and restore the mucous track to a healthy state, and the fistula will then generally close of itself. This rule holds good in lacrymal fistulæ, and for this purpose the canaliculi should be laid open, and a probe passed into the sac and nasal duct to ascertain if there is any stricture or disease of the bony walls.

If a stricture be detected, it must be dilated with probes in the manner already described. Should there be a chronic thickening of the mucous membrane with a muco-purulent discharge, the sac must be washed out twice or three times a week with an astringent lotion by means of a lacrymal syringe.

If this treatment fails, the fistula should be laid freely open into the sac with a cataract knife or fine scalpel, the point of which is to be passed through the fistulous opening on the face into the membranous portion of the canal. The sides of the fistula are then scraped with a sharp spoon, and the wound made to heal from the bottom by inserting a fine strip of gauze or lint, which may be gradually shortened as healthy reparative action sets in. This treatment, combined with the use of probes and syringing out the sac, seldom fails to cure the fistula. Further, in those cases where the fistulous opening on the face is large, it will be often found of service to pare the edges of the opening and unite the raw surfaces with a fine suture.

Some few cases will, however, remain obstinate, and it is then best to remove the remains of the sac, either by the method described on page 445 or by free scraping with a sharp spoon if the parts are too disorganised to admit of a clean extirpation.

EPIPHORA FROM MECHANICAL OBSTRUCTION BY TUMOURS.—The cavity of the lacrymal canal may be partially or completely occluded by tumours which take their origin from within the sac, or by those which grow from the antrum, the nostril, or from the base of the skull. It would be out of place here to discuss the nature and treatment of such growths; they will be found fully described in works on general surgery. It is sufficient to indicate that epiphora may be caused by the presence of tumours either within or in the neighbourhood of the lacrymal sac, so that the surgeon may not disregard the possibility of their existence in obstinate cases which have persistently resisted all treatment.

INFLAMMATION OF THE LACRYMAL GLAND—DACRYO-ADENITIS.

The inflammation may be either chronic or acute; generally, however, it is the former. It may occur without any apparent cause, or it may arise from injury.

Symptoms.—When **chronic** there is tenderness and enlargement of the gland, which can be felt by the finger beneath the outer part of the edge of the roof of the orbit, and occasionally a prolongation of the enlarged gland will extend into the upper lid. There will probably be also some œdema of the oculo-palpebral fold of conjunctiva and redness of the lid. If there is much swelling of the gland, the eye will be displaced downwards and inwards.

A chronic form of inflammation, or rather of degeneration, occurring in cases of lacrymation or epiphora of any origin, whether caused by inflammations of the eye, eyelids, or by lacrymal obstruction, has been described and investigated by Bock,* Stanculéanu and Théohari,† and de Schweinitz.‡ The changes, which consist in a small-celled infiltration surrounding the ducts and in the interstitial connective tissue, with

* 'Zur Kenntn. der Gesunden und Kranken Thränendrüse,' Wien, 1896.

† 'Arch. d'Ophthalmologie,' vol. xviii, 1898, p. 737.

‡ 'Trans. Am. Ophth. Soc.,' 1900.

swelling and degenerative changes in the glandular epithelium, have hitherto passed unnoticed, probably because the gland itself is not enlarged and there is an absence of all clinical symptoms which might attract notice. Stanculéanu and Théohari found similar conditions in the lacrymal glands of dogs after the induction of hypersecretion by injections of pilocarpine. The special interest of these investigations lies in the explanation they offer of the relief of epiphora after excision of the lacrymal sac for chronic dacryo-cystitis (*see* page 441).

If the inflammation is **acute**, there will be pain, redness, and swelling in the region of the gland, with œdema of the lid and chemosis of the conjunctiva. These symptoms may subside under treatment, or they may go on to the formation of pus.

In one case of subacute inflammation of the lacrymal glands which was under our care both glands were affected symmetrically, and a portion of the enlarged glands could be seen and felt in the outer part of each upper eyelid, causing the lids to droop over the eyes. Under a few weeks' treatment the swelling of the glands completely subsided. The disease in its progress seemed to be very analogous to an attack of mumps.

FISTULA OF THE LACRYMAL GLAND (*Dacryops fistulosus*) may be the result of an abscess of the lacrymal gland which has burst externally, or of a cyst of the gland, or of an incised wound. There is a minute opening in the upper and outer surface of the lid, through which the tears trickle from time to time.

Treatment.—The edges of the fistulous opening may be pared with a fine scalpel, and be then brought together with a single wire suture; or a fine-pointed cautery may be introduced into the fistulous orifice.

In a case of Bowman's* a cure was effected by passing a seton through the fistula and bringing both ends out on to the conjunctival surface of the lid, about a quarter of an inch from each other, so that the fistula was pierced at two points by the thread, which encircled in a loop a small intervening portion of tissue. The seton was allowed to remain about three weeks, after which it was withdrawn and the encircled bridge of tissue cut out. In this way a permanent opening was secured on the conjunctival surface of the lid, through which the fistula drained, thus enabling the cutaneous orifice to be successfully pared and sutured.

TUMOURS OF THE LACRYMAL GLAND.

SIMPLE HYPERTROPHY of the lacrymal gland is occasionally met with. The enlarged gland forms an unsightly prominence in the upper and outer part of the orbit.

Treatment.—The unguent. ammonii iodid. gr. xx ad adipis gr. ccxl, or some other absorbent ointment, may be rubbed into the swelling night and morning, and small doses of iodide of potassium, or of the

* 'Roy. Lond. Ophthalm. Hosp. Reports,' vol. i, p. 288.

syrup. ferri iodid., may be given twice a day. Should this treatment have no effect, the unsightly prominence may be excised; or the whole gland may be removed.

CYST OF THE LACRYMAL GLAND—DACRYOPS.—A dacryops is a retention cyst of the lacrymal gland. It is of excessive rarity, and Rogman,* in an exhaustive paper, only succeeded in collecting twenty-four cases, two of which were under his, and one under our own observation.†



FIG. 208.—A case of hypertrophy of both lacrymal glands. The right was completely excised, and the protruding portion removed from the left. The result was very satisfactory.

The cyst forms a painless fluctuating swelling, over which the skin is freely movable, situated in the region of the lacrymal gland. On eversion of the upper lid it bulges into the fornix, and from the delicate nature of its walls presents a bluish translucent appearance. A characteristic symptom of dacryops is the enlargement of the tumour when the patient cries; but this symptom has not been present in by any means all of the cases. The cyst may attain considerable size, as in our own case, which was as large as a pigeon's egg (Fig. 209), and if so, ptosis, slight exophthalmos, and limitation of movement

upwards may be expected. In our own case the cyst was loosely attached in every direction except along the conjunctival fornix, where the adhesions were firm.

Treatment.—The cyst should, if possible, be removed without opening it, either by dissection through the conjunctival fornix or by an external incision as may seem most suitable. If the former method is chosen, the outer canthus should be divided to permit of the most complete eversion of the lid.

If any portion of the cyst wall is left behind, a troublesome fistula will probably result.



FIG. 209.—A large dacryops, the anterior wall of the cyst showing the attachment of the subconjunctival tissue. The walls were of extreme delicacy, and it was filled with a pale straw-coloured fluid.

SARCOMA of the lacrymal gland is a very rare disease. In the few cases which we have seen, it has occurred as an infiltration into the gland tissue, and formed a distinct tumour growing into the upper eyelid from beneath the upper and outer edge of the orbit.

The growth is accompanied by proptosis and displacement of the eye downwards and inwards.

* 'Ann. d'Ophtalm.,' vol. cxxi, June, 1899.

† 'Trans. Ophth. Soc. U. K.,' vol. xvii, p. 233.

Treatment.—Early removal of the growth is the only remedy. The removal of a lacrymal tumour is apt to be followed by ptosis owing to division of the levator palpebræ muscle (*see* “Anatomy”), and the sixth nerve also stands in some danger of being divided. Both these accidents occurred to the author in removing a small-celled sarcoma of the lacrymal gland.

Epithelioma, adenoma, and fibro-adenoma are other rare forms of lacrymal tumour that have been described.

Concretions or dacryoliths are occasionally formed in the excretory ducts of the gland.

Tubercular infiltration of the gland may also occur.

REMOVAL OF THE LACRYMAL GLAND.—An incision is to be made immediately below the upper and outer third of the orbital ridge, through the skin and the fascia connecting the periosteum of the orbit with the upper edge of the tarsal cartilage. The gland is then to be carefully felt for with the finger, and having made out its exact position, it is to be seized with a pair of hooked forceps and drawn forwards out of the wound, whilst its cellular connections are carefully severed with a knife. Free hæmorrhage often accompanies the operation, but the bleeding is usually arrested without much trouble. Care must be taken to avoid dividing the tendinous expansion of the levator palpebræ, which runs between the superior and inferior divisions of the gland.

The removal of the *palpebral* portion of the gland alone is best effected by an incision through the outer third of the conjunctival fornix. The lid is everted and the eyeball rotated downwards, and if necessary the external canthus is divided in order to secure the greatest possible amount of eversion. The gland lies immediately under the conjunctiva, and is removed by grasping it with tenaculum forceps and freeing it from its surrounding attachments with knife and scissors. The conjunctival wound is then closed by one or two fine silk sutures.

CHAPTER XXVI.

DISEASES OF THE EYELIDS.

ANATOMY.—Of the two eyelids, the upper is the larger, the deeper, and the more movable. Each eyelid consists of the following structures from before backwards:

1. *Skin*.—This is smooth, very delicate in texture, devoid of subcutaneous fat, and connected with subjacent structures by loose areolar tissue.

2. *Palpebral Portion of the Orbicularis Muscle*.—This is a fine stratum of arching fibres, which intersect at the angles of the lids, and are inserted into the internal and external tarsal ligaments.

3. *Tarsus*.—This consists of a firm plate of fibrous tissue, which forms the chief framework of the lids. That of the upper lid is much the larger of the two, and has inserted into its upper border the expanded tendon of the levator palpebræ superioris. Associated with the latter is a layer of unstriped muscle-fibres under the control of the sympathetic, which aids the levator in the elevation of the lid, and is known as "*Müller's muscle*." There is a similar stratum of unstriped fibres in the lower lid, but it is much more delicate and is of little importance.

Each tarsus is connected to the orbital arch by a strong band of tissue known as the "*fascia tarso-orbitalis*" or "*septum orbitale*," that of the upper lid being far the stronger of the two. Externally, the tarsus forms attachment to the malar bone by the external tarsal ligament, and internally to the nasal process of the superior maxilla by the internal tarsal ligament or tendo oculi. The latter is the more defined, and is important on account of its relation to the lacrymal sac and the method of the insertion of the orbicularis muscle at this spot (see page 436).

4. *Meibomian Glands*.—These consist of a row of modified sebaceous glands which are placed at right angles to the free margin of the lid, and lie embedded in the posterior or conjunctival surface of the tarsus.

5. *Palpebral Conjunctiva*.—This is closely adherent to the tarsus (see also page 96).

The free margin of each lid is flattened, and contains along its anterior border the eyelashes or *cilia*, which are grouped in two or three rows, those of the upper lid being thicker, longer, and upcurved at their free ends. Around the follicles of the cilia are grouped small sebaceous glands, technically known as "*Zeiss's glands*," and also a few sweat-glands, also specially known as "*Moll's glands*."

The posterior border is occupied by the orifices of the ducts of the Meibomian glands, which are separated from the cilia by a well-defined space known by its coloration as the "*grey line*," through which the lid can be easily split into two portions, the one containing the cilia, the skin, and orbicularis, and the other the tarsus and Meibomian glands.

The points of meeting of the two lids are known as the "*Commissures*" or "*Canthi*." The external commissure is well-defined and angular; but the internal is rounded and elongated, bounding the lacus lacrymalis, and containing the canaliculi in its upper and lower margins.

The space between the lids when the eyes are open is known as the "*Palpebral fissure*." It varies much in size in different people, this chiefly constituting the difference between what are generally known to the public as large and small eyes. In all cases a small arc of the cornea is concealed by the upper lid, whilst the upper level of the lower lid varies a good deal, generally just allowing exposure of the lower corneal limbus, but occasionally reaching considerably higher, or showing a narrow line of sclerotic below the cornea.

CONGENITAL ABNORMALITIES.

COLOBOMA is a rare deformity limited to the upper lid. It generally appears as a small V-shaped notch in the free border of the lid at the junction of its middle and inner third. Occasionally the gap attains considerable size, and sometimes it extends through the width of the lid to the oculo-palpebral fold. Very rarely two notches are present close to each other, leaving a small semi-detached area like a double hare-lip between them, and in other cases, again, the defect is symmetrical. No convincing developmental explanation of the origin of coloboma of the lid is at present forthcoming.

Treatment.—If the notch is small, the edges may be pared and brought together by sutures. Large colobomata are unamenable to treatment.

EPICANTHUS.—This term is applied to a crescentic fold of skin, which slightly overlaps the inner canthus of each eye. By increasing the breadth of the integument between the eyes, a peculiar Chinese expression is given to the face, which is sometimes distasteful to the patient or his relatives. Epicanthus usually decreases as the child grows and the bridge of the nose is developed. It never interferes with sight.

Treatment.—It is only in extreme epicanthus that any operative

proceedings should be adopted. In such cases a vertical ellipse of skin may be excised from the centre of the space between the eyes, and the edges of the wound united with sutures. In this way the crescentic folds of integument will be unravelled, and the canthus of each eye exposed.

CONGENITAL PTOSIS.—See “Ptosis,” page 471.

ABSENCE OF EYELIDS—ABLEPHARIA.—Complete absence of both eyelids is a very rare occurrence. Sometimes the upper lid is so short that it fails to cover the globe, a condition known as **Congenital “Lagophthalmos.”**

CRYPTOPHTHALMOS.—This name is given to a very rare anomaly in which the eyelids fail to be developed, and in their place a fold of the integument passes uninterruptedly from brow to cheek, concealing the eye from view.

Several other rare congenital deformities may be found in connection with the lids, which need no special description. Thus the lids may be united at one spot to the globe (**symblepharon**) or to each other (**ankyloblepharon**), or the palpebral aperture may be abnormally small (**blepharophimosis**). Congenital eversion (**ectropion**) or inversion (**entropion**) may also occur, and Sydney Stephenson* has drawn attention to a congenital form of **Trichiasis** in which the intermarginal space is almost normally placed, and which, therefore, cannot properly be classed with entropion. He attributes these cases to under-development of the tarsus.

ŒDEMA OF THE LIDS.

This may be—(1) *Inflammatory* (see “Inflammation,” page 453).

(2) *Non-inflammatory*.

Non-inflammatory œdema may be the result of—

a. **Constitutional disease**, such as kidney or cardiac disease when it is merely a manifestation of general anasarca.

b. **Emphysematous swelling** following upon fracture involving the frontal or ethmoidal sinuses (see page 490).

c. **Angioneuroses**.—A term given to the formation of transient wandering swellings occurring most commonly in women, and supposed to be of an urticarial nature and due to some derangement in vaso-motor innervation. The lids are only one of many sites affected by these local swellings. A characteristic history is the rapid formation, without any apparent cause and unattended by any inflammatory or subjective symptoms, of an ill-defined tumour, which persists for a short time and then disappears with equal rapidity, leaving no trace of its presence. The duration of the swelling is sometimes exceedingly short, and may not extend over twenty-four hours from the time of its first

* ‘Trans. Ophth. Soc. U. K.,’ vol. xiv, p. 1.

appearance, but its disappearance in one place is followed at variable intervals by the formation of a fresh swelling of a similar nature either at the same spot or elsewhere on the body.

We have recently had under our care a peculiarly interesting instance of this affection. The patient was a boy aged twelve years, and in him the swelling was, in contradistinction to the rule, always limited to the right lids. It invariably came on during the night during sleep, reached its height during the following morning, and had entirely disappeared within the next forty-eight hours. No cause could be assigned for these attacks, which occurred regularly once or twice a month or oftener. The œdema was sufficiently great to entirely close the eye for the time being, but the discomfort thus caused was the only complaint. The boy was very bright and intelligent, but decidedly of the highly strung sensitive type.

d. Solid Œdema of the Lids.—The œdema in these cases is the result of lymphatic obstruction, and the affected tissues undergo permanent alteration in structure such as is seen in elephantiasis. The lids are much hypertrophied, and form flabby elastic swellings which produce great disfigurement. In most cases the cause of the obstruction to the lymphatic circulation has been traced to a previous attack of facial erysipelas.

Permanent improvement may be obtained in some cases by excising portions of the redundant growth; but in others the benefit thus obtained has been only temporary, and the deformity has gradually reappeared.

INFLAMMATION OF THE LIDS—BLEPHARITIS.

Inflammatory swelling of the lids may be *primary*, *i. e.* due to pathological conditions arising in the lids, or may be *secondary* to inflammation originating in neighbouring parts. Primary inflammation occurs as a result of wounds, injuries, or ulcerations of any of the component parts of the lids, in which list the cilia, the palpebral conjunctiva, and the Meibomian glands are to be included. Secondary inflammation is seen in orbital cellulitis and inflammation of the lacrymal apparatus, and sometimes in deep inflammations of the eyeball. On account of the loose nature of the subcutaneous tissue, œdema is always a marked feature of inflammatory affections of the lids.

ABSCESS OF THE LID.—From contusion or laceration of the integument of the lid, acute inflammation and suppuration of the sub-jacent cellular tissue may follow. The eyelid becomes red, swollen, and shining, and unmistakable evidence of pus is soon manifested. The treatment is the same as for an abscess in any other part of the body. As soon as it is clear that pus has been formed, an incision should be made to give vent to it, and warm fomentations should be afterwards applied. The only point which requires special notice is the way in which the abscess should be opened. The incision should be made with a fine sharp knife in the horizontal direction, and in a line with the orbital fold of skin just beyond the lid. The cicatrix will then be a mere line, and from its situation it will be scarcely observable.

ULCERATION OF THE LIDS.—This may be (a) traumatic, (b) syphilitic, (c) tubercular, or (d) malignant.

a. **Traumatic ulceration** may follow lacerations, contusions, or punctured wounds. The condition requires no special description. The treatment consists in the application of antiseptic lotions or ointments, as may be thought best. The close proximity of the eye must be borne in mind if it is considered necessary to apply any strong solution.

For ulceration of the tarsal border see “Ciliary Blepharitis,” page 455.

b. **Syphilitic Ulceration.**—Either the upper or lower lid may be the site of a *primary hard chancre*, the virus being probably conveyed either by a contaminated finger, or by kissing when secondary ulcers have been present on the tongue or tonsils. Cases of this sort are, of course, rare; but we have seen a fair number, and in one instance the patient was under two years of age. The appearance of the sore is characteristic, exhibiting the painless induration and slight ulceration with thin watery discharge of a penile chancre, together with shotty enlargement of the pre-auricular gland. The diagnosis in any doubtful case will be cleared up by the advent of a general secondary rash.

Secondary syphilitic sores on the lid resemble very much in appearance epithelial ulcers, for which they may be easily mistaken. They usually commence close to the tarsal margin, which they partially destroy, leaving a notch which is very characteristic of the disease. The ulcer will often heal at the point where it first commenced, whilst at the same time it extends itself in the opposite direction. In this respect it differs from the rodent or epithelial sore, in which there is no real repair of any portion of the ulcerated surface. The previous history of the patient, when it can be truthfully obtained, is also an important guide in the diagnosis; but in cases of doubt a week or ten days' treatment with antisyphilitic remedies will usually decide the true origin of the disease.

Treatment.—As an application to the sore, a weak mercurial ointment or lotion. Internally, a mixture with iodide of potassium and pil. hydrarg. subchlor. comp. gr. v every other night; or the liq. hydrarg. perchlorid. may be given two or three times daily; or the iodide of potassium and perchloride of mercury may be combined in the same mixture. If the patient be a child, the pulv. hydrarg. cum cretâ (gr. i—gr. ij) may be given every night, or night and morning, and during the day small doses of the syrup of the iodide of iron, or of potassium iodide combined with iron.

c. **Tubercular Ulceration.**—Lupus vulgaris may spread to the lower lid by continuity from the cheek. Lupus very rarely attacks the upper lid.

d. **Malignant Ulceration.**—See “Malignant Tumours,” page 470.

INFLAMMATION OF THE TARSUS—TARSITIS.—As a primary disease, inflammation of the tarsus is rare, and in most cases it is of syphilitic

origin. When due to this cause, it consists of a slow, painless, and indurated enlargement of the tarsus, comparable to the interstitial orchitis which occurs in the late secondary stage of syphilis.

A secondary involvement of the tarsus is common in all long-standing inflammations of the lids and their conjunctival lining, and to this is due the great deformity so frequently associated with old trachoma and ciliary blepharitis. In severe cases of this sort the tarsus becomes shrunk, incurved, and thickened; the lower free border, which is unsupported, becomes rolled upon itself, rounded and hypertrophied, and the whole lid loses its pliability and symmetry of outline, drooping, in the case of the upper lid, in a characteristically sleepy fashion over the eye.

Treatment.—Primary syphilitic tarsitis calls for energetic treatment with mercurials and iodides, under the influence of which the swelling may undergo partial or complete resolution. Secondary inflammation of the tarsus requires no special consideration apart from its originating cause, but the permanent and severe deformities so often seen as the result of the implication of this structure should serve as an incentive to the most active perseverance in the treatment of the primary disease.

AFFECTIONS OF THE CILIA.

INFLAMMATION OF THE CILIARY FOLLICLES—CILIARY BLEPHARITIS.—This may be present in three different classes of cases.

1. **As a concomitant of chronic inflammatory conditions of the conjunctiva**, it is seen under a variety of causes. The line of demarcation between palpebral conjunctiva and skin is easily overstepped, and, consequently, secondary inflammation of the lid borders is a very common complication of conjunctival affections. Its presence is signalised by hyperæmia of the skin and excess of secretion from the ciliary follicles, as well as by some increase in the subjective symptoms of photophobia and lacrymation. The overflow of the tears still further irritates the inflamed skin edges, which break down, producing painful superficial cracks and excoriations, which are always most severe about the external commissure.

The **treatment** resolves itself into the cure of the primary conjunctival inflammation, aided by the application of a little boracic or weak mercurial ointment to the edges of the lids.

2. **As a Chronic Seborrhœa.**—This is especially a disease of childhood, and is very common in children of a strumous diathesis. The condition is closely allied to, and frequently accompanies, chronic seborrhœa of the scalp. The epithelium of the tarsal border scales off, and mixed with the inspissated sebum of the ciliary follicles, which is secreted in excess, forms crusts which adhere to the roots of the lashes. The signs of inflammation are, in many cases, very slight, and limited to a little redness of the tarsal borders, which is manifested by a feeling of chronic soreness and itching. Frequently, but by no means always,

an error of refraction, most commonly hypermetropic in nature, is at the bottom of the trouble by causing chronic congestion and irritability of the eyes. In mild cases the discharge is slight and powdery, and this, in addition to the frequency with which the child rubs the eyes to alleviate the itching, prevents the formation of readily apparent crusts; but close examination will always reveal the presence of small adherent scales and a flaky condition of the epithelium, whilst there is also a history of gumming of the lids together on awaking from sleep.

These cases are essentially chronic, and may drag on indefinitely if suitable treatment be not adopted, without getting either much better or much worse. On the other hand, owing to the rubbing of the eyes with dirty fingers infected from impetiginous ulcers of the head or face, or the discharge from an otitis media, many cases ultimately assume the third or severest type of ciliary blepharitis.

Treatment.—The determination and correction by suitable glasses of a possible error of refraction must be the first endeavour, and if this be the exciting cause, the case will give little trouble afterwards. The local treatment to be adopted consists in strict cleanliness, the use of a mild alkaline lotion such as the *Lot. Sodii Bicarb.* (F. 53), by which the adherent scales are most easily removed, and the anointing of the tarsal borders night and morning with a little stimulating mercurial ointment such as the *Ung. Hyd. Ammon. Dil.* or the *Ung. Flav. Dil.* (F. F. 62, 66). In addition, a course of treatment with cod-liver oil and iron, Scott's emulsion, or Kepler's extract of malt, is very useful in strumous children.

3. As Pustular Ciliary Blepharitis—Tinea Tarsi.—This is the most severe form of ciliary blepharitis, and is frequently followed by permanent malformation of the lids and destruction of the ciliary follicles. It may arise as a primary inflammation, or, as mentioned above, it may follow upon a chronic seborrhœa. As a primary affection it is common among the children of the poorer classes, and especially among the dirty and neglected who suffer from impetiginous sores about the head, nostrils, and ears. It is also frequently associated with debility and constitutional derangement, and is one of the sequelæ of scarlet fever, whooping-cough, and measles. It is chronic in its progress, exceedingly difficult to subdue, and very apt to recur when from any cause the patient's health fails.

In the early stage the margins of the lids are red and irritable; there is at first an excessive secretion from the follicles of the cilia, which accumulates during the night, and causes the lids to be gummed together in the morning. As the disease advances, the discharge becomes purulent and cakes into scabs, which adhere to the margins of the lids and to the lashes. Small pustules then form at the roots of the lashes, and these burst and leave superficial ulcerations, which are generally covered with yellow crusts. The eyelashes gradually fall out, and the edges of the lids lose their sharp outline and become rounded, thickened, and everted. With the eversion of the tarsal border, the punctum lacrymale is drawn away from the globe, and there is a slight but constant overflow of tears, which excoriates the

lids and keeps up the redness and irritation. To this, the extreme stage of tinea tarsi, the term **lippitudo** has been applied.

Treatment.—One of the most important elements in the treatment of tinea tarsi is strict cleanliness. The first thing to do is to remove the scabs of dry secretion from the roots of the lashes. This is most easily and effectively done by a weak bicarbonate of soda lotion (F. 53), with which the lids should be bathed night and morning, or oftener if the discharge is severe. The lids should then be anointed with a little mercurial ointment, such as the Ung. Hyd. Ammon. Dil. (F. 62), or the Ung. Hydrarg. Nitratis Dil. (F. 65), both of which are excellent preparations, though the latter is apt to cause some pain. If the lashes are long and thick, it is a good plan to cut them off close to the lid; or if the pustular formation be excessive, it is better to remove them by epilation—a little operation that generally causes but slight pain, as the lashes are only loosely held in the inflamed tissue. Remedial agents are thus more easily and thoroughly applied, and the lashes will speedily grow again if the follicles themselves have not been destroyed by the inflammatory process.

Besides the use of lotions and ointments, severe cases require the nitrate of silver solution (grs. v to grs. x ad ʒj), which should be applied daily with a camel's-hair pencil to the pustules and ulcerated spaces between the lashes; or, in place of the solution, the diluted nitrate of silver stick may be used two or three times weekly. In the worst cases, where the edges of the lids are rounded, thickened, and excoriated, with the puncta drawn away from the globe, the lower canaliculi should be slit in the manner directed on page 442, so as to form conduits, along which the tears may flow into the sac; and a weak solution of nitrate of silver should be painted daily on the red excoriated margins. As an alternative lotion, the Glyc. Boracis (F. 42) is very useful, especially when the discharge is great and the lids very irritable.

During treatment the eyes should be carefully guarded from wind, glare, and dust by neutral-tinted protectors; or if, as is sometimes the case, there be a high degree of refractive error present, the correcting glasses should be of large size, and of a neutral tint for outdoor wear.

Whilst ordering local applications to the lids, attention must also be paid to the state of the patient's health. Tonics of cod-liver oil, iron, and quinine usually do good; but in very chronic cases, accompanied by a thickened and eczematous state of the lids, small doses of the liquor arsenicalis given twice or three times a day will be often of service. It is, however, a medicine which should be seldom prescribed for young children.



FIG. 210.—Cilium or epilation forceps for removal of the eyelashes.

HORDEOLUM—Stye—is a small boil on the margin of the lid, arising in connection with the ciliary follicles. Generally only one stye appears at a time on the lid, but others are very apt to follow. A succession of them is indicative of an enervated state of health.

(For the differential diagnosis between hordeolum and marginal chalazion *see* page 468 and Fig. 213.)

Treatment.—In the early stages, when the patient feels that a stye is beginning to form and before suppuration has commenced, the process may sometimes be arrested by painting the margin of the lid with collodion, taking care that none drops into the eye. The traction on the part caused by the drying of the collodion is sometimes sufficient to cause absorption of the inflammatory material. Another method sometimes also very successful is to produce a little counter-irritation by drawing once across the tender spot a point of the mitigated nitrate of silver stick. Both of these remedies are worth trying, as the patient is in no way worse off if they fail.

During the advance of the stye, warm applications are best: fomentations with hot water or the decoction of poppy heads, and a warm fomentation at night covered with a piece of oil-silk. It is seldom necessary to puncture a stye; the pus will select its own site at which to point and make an exit for itself. The patient is usually in an indifferent state of general health, and medicinal treatment is always important. The bowels should be cleared of all irritating matter by a purgative, and some tonic prescribed; usually the mineral acids with bark or quinine with the perchloride of iron agree very well. In children a mild alterative, such as the pulv. hydrarg. \bar{c} cretâ gr. j to gr. ij, taken every night or every other night for a week, is very useful, and this should be followed by a course of cod-liver oil, either alone or combined with iron or malt. When all suppuration has ceased the lids may be bathed with a slightly stimulating lotion (F. 44), and at bedtime a little of the Unguent. Hydrarg. Nitratis Dilut. (F. 65) may be smeared on the tarsal edges.

PHTHIRIASIS—PEDICULOSIS.—Rarely the lashes and eyebrow are infected by pediculi pubis. The disease bears a strong superficial resemblance to ciliary blepharitis, and its true nature may be easily overlooked. It is to be distinguished by the peculiar dark colour and powdery nature of the scabs which adhere to the roots of the cilia, and which contain the nits of the lice. In cases of doubt, examination with a convex lens will at once reveal the specific cause. It is worth noting that pediculi capitis have never been known to become located in either the eyebrows or cilia, even though swarming in the head.

Treatment.—The lice are easily killed by inunction with a mercurial ointment for a few days.

MONILETHRIX (Crocker), or beaded hair, is a very rare condition in which the cilia may become affected as part of a more general affection of the hair. The disease, which has a strong family tendency, consists in a partial arrest in growth of the hair at certain points, giving it a peculiar beaded appearance. Between the site of each

bead or node the medulla ceases to grow, and the development is confined to the cuticle of the hair, the latter thus becoming very fragile and brittle at the internodal portions. An interesting example has been recorded by Treacher Collins.* The condition, being developmental, is not amenable to treatment.

CYSTS OF MOLL.—Little retention cysts may form in the modified sweat-glands or Moll's glands which lie round the ciliary follicles. They form little grey translucent tumours, which produce no symptoms, and only require treatment on account of the slight deformity they cause when they grow to any size.

Treatment.—The cyst may be evacuated with a little incision or removed bodily with scissors or knife, in which case a small raw spot will be left, which will require a simple dressing for a few days.

ALOPECIA.—The cilia and eyebrows may be lost in a general alopecia. No treatment is of avail, but the patient will derive comfort from neutral-tinted protectors for outdoor wear.

TRICHIASIS AND DISTICHIASIS are conditions which usually occur together. Trichiasis implies an irregular displacement of the lashes, some of which are inverted, and often stunted in their growth. By distichiasis is meant the shifting of the ciliary follicles in such a way that there is a distinct double row of lashes. The inner row is usually turned inwards, and sometimes so completely that the lashes cannot be seen without slightly everting the lid with the finger. Both trichiasis and distichiasis may be partial, or may involve the whole of the cilia; but even when of slight degree the displaced lashes cause great irritation by brushing against the cornea, which becomes nebulous and vascular, and not infrequently ulcerated. The corneal inflammation causes great pain with photophobia and lachrymation, owing to which the patient keeps the eyes convulsively closed (*blepharospasm*), and by so doing causes a still greater approximation of the incurved lashes to the cornea, and establishes a vicious circle. In addition, the overflow of the hot tears on to the cheek causes painful superficial excoriations and fissures of the skin, especially about the external commissure, which increase his misery, and may in healing cause some narrowing of the palpebral aperture (*blepharophimosis*). If the condition is not relieved by artificial means, matters will go from bad to worse; the cornea gradually becomes opaque, and in time the sight will be completely destroyed.

To understand the **ætiology** of trichiasis and distichiasis it must be remembered that for the healthy natural growth of the lashes two principal factors are necessary—(1) that the ciliary follicles shall be healthy, and (2) that the follicles shall be properly placed so that the lashes may grow in the right direction.

The conditions which are most liable to interfere with these two factors are ciliary blepharitis of a severe type (*tinea tarsi*) and cicatricial entropion. After prolonged disease of the tarsal border, the ciliary follicles may either be destroyed outright, in which case no

* 'Trans. Ophth. Soc. U. K.,' vol. xix, p. 1.

further growth of cilia will occur, or may be so damaged that the cilia are ill-developed and stunted. This stunting frequently applies both to length and texture, the latter being in many cases so atrophied that it is difficult to detect the lash without the aid of a convex lens. At the same time, the cicatrices which result from the inflammation may cause displacement of the follicles, so that the new cilia grow in abnormal directions, generally pointing more or less towards the globe. Similarly, in entropion cicatricial traction causes general incurvation of the tarsal cartilage, and with it of the cilia themselves; whilst the inequality of the drag at different spots causes an irregularity in the effect produced, and the follicles are consequently shifted both as regards their grouping with one another and also in the directions of their individual growth.

Treatment.—If the incurved lashes are removed by epilation, which is easily effected by cilium forceps (Fig. 210), the symptoms are at once relieved; but such treatment is purely palliative, as the lashes speedily grow again. If the displaced lashes are not very numerous or scattered, the best treatment is to remove them permanently by **electrolysis**. This is rather a painful proceeding, so that only a few lashes should be thus treated at one sitting. The needle, attached to the negative pole, is thrust into the skin by the side of the lash to be removed, whilst the positive electrode, in the form of a plate or sponge, is placed on the brow, temple, or nape of the neck. A current of from 4 to 6 cells is usually sufficient, and, on closing, a few small bubbles of hydrogen gas will rapidly form round the needle, which is kept in position for a few seconds, and then withdrawn, after which the lash will be found to be easily detached if the follicle has been successfully destroyed.

When the inverted lashes are numerous or embrace the greater part or whole of the ciliary border, more severe measures are necessary, and the case must either be treated by one of the methods advocated for entropion, such as by **Arlt's operation** (see page 479), or the ciliary follicles may be removed by **Ablation**. The choice of method must depend upon the merits of the individual case; undoubtedly when the lashes are fairly thick and not unduly deformed, their preservation should be attempted for cosmetic and other reasons; but they may be so incurved or the entropion of such a nature that no operation will suffice to place them out of harm's way; or they may be so deformed that their removal will be of cosmetic advantage, and in such cases ablation is the measure to be adopted.

Ablation of the Cilia.—If the inverted lashes occupy as much as half the tarsal margin, it is better to excise the whole row, as the result is less noticeable than when half of the cilia have been removed.

The operation consists in first splitting the border of the tarsal cartilage and then excising the thin wedge of it, in which the bulbs of the lashes are embedded. The lid being drawn tense by one hand of the operator, with the other he makes a long incision with a Beer's knife along the inner or ocular edge of the lashes, and of a sufficient depth for the point of the knife to pass beyond their roots. A second incision is now to be made on the outer surface of the lid just behind,

but parallel to, the row of lashes, so as to cut through the integument and the margin of the cartilage just above the bulbs of the cilia; the depths of the two incisions will thus meet, and the whole row of lashes will be excised. The cut surface of the cartilage should now be carefully scanned over, so that if any of the bulbs of the lashes have escaped excision, they may be removed. Should any be left, new lashes will sprout again from them, and the object of the operation will not be completely fulfilled, as even a single eyelash brushing against the cornea will cause considerable irritation. The bulbs of the lashes may be recognised by their appearing as fine black dots. Lastly, the skin should be gently pressed over the cut edge of the cartilage, and a dry compress smeared over with a little boracic ointment applied. No sutures should be used.

To facilitate the performance of this operation, and to protect the eye, it is always best to use either a horn spatula (Fig. 226) or some kind of entropion forceps such as Desmarres' (Fig. 227). If the latter are selected, the broad blade should be gently insinuated beneath the eyelid as far as it will pass, and then, with a few turns of the screw, a metallic clamp is made to firmly compress the circumference of the lid with the exception of its tarsal border, which is left free for the operator.

DISEASES OF THE SKIN OF THE EYELIDS.

Diseases of the cilia have been already described in a special section. The eyelids may be affected in a great variety of diseases of the skin, and only those will be mentioned which are likely to come under the observation of the ophthalmic surgeon.

ECZEMA OF THE LIDS frequently accompanies strumous keratitis and phlyctenular ophthalmia in children. It also frequently occurs with conjunctivitis and ciliary blepharitis, and in many cases is associated with eczema behind the ear and sores about the nostrils. It thus rarely occurs alone or as a primary affection.

Treatment.—The child is nearly always in a poor state of health, and is often anæmic. Treatment should be commenced with a few days' course of a mild alterative such as pulv. hyd. \bar{c} cretâ gr. j, either alone or combined with a small dose of bicarbonate of sodium (gr. iij to v), after which a mixture of cod-liver oil, with iron or malt extract, or a course of Parrish's food should be prescribed. The remedies to be used locally vary with the type that the eczema has assumed. When there is much inflammatory œdema, and the skin is very tender, raised in vesicles, or exhibits weeping ulcers, a non-irritating powder of boracic acid, combined with a little starch and rice powder, should be dusted once or twice daily over the affected area, and the parts protected by a light compress moistened with a weak borax solution (F. F. 42, 43, 44). When, however, the eczema is of an impetiginous type, accompanied by the formation of scabs and crusts, these should be soaked away with a little sweet oil or soda lotion (F. 53), and the raw surface underneath smeared with a little of the Ung. Hyd. Ammon. Dil. (F. 62).

SYPHILITIC ERUPTIONS.—See "Ulceration of the Lids," page 454.

MILIUM is a little aggregation of inspissated sebaceous material beneath the epidermis. Many such little collections may be present, forming groups of pearly seed-like swellings, or there may be one or more discrete tumours of larger size. The growth of milium is slow; it produces no symptoms, and is perfectly harmless.

Treatment.—If sufficient in size or number to cause annoyance, each milium should be incised, and the contents squeezed out between the finger and thumb.

MOLLUSCUM CONTAGIOSUM.—The face is one of the most frequent sites for the appearance of these little tumours. The molluscum appears as a small semi-lucent tumour with a characteristic umbilication, from the centre of which a tiny aperture, which is always blocked, leads into the interior of the growth. These tumours are not connected with the sebaceous glands, as has been very generally believed, but consist of a peculiar overgrowth of the deeper layers of the epidermis; and their contents, forming a mass of cheesy material, are composed chiefly of epithelial debris. The growth of a molluscum is slow, and, having reached a certain size, usually that of a small pea, the tumour may remain stationary for an indefinite period.

Treatment.—The inoculability of molluscum has now been conclusively proved both clinically and experimentally, though the specific cause is not equally clear; and on this ground alone the destruction of these tumours should be carried out. This is easily effected by the evacuation of their contents by pressure between the finger and thumb, aided, if necessary, by a small incision. The larger growths may require, in addition, a little curetting with a small Volkmann's scoop.

WARTS.—These are most commonly situated near the tarsal edge of the lids.

Treatment.—They should be excised, and their bases touched with the solid nitrate of silver stick.

SEBACEOUS HORNS.—These are occasionally found growing from the tarsal margin, especially of the upper lid. They are due to the heaping up of dried sebum round the lashes, the latter forming a framework upon which the horn is built up. These horns are therefore usually seen in dirty and neglectful patients, who, from timidity or indifference, fail to keep the lashes clean.

Treatment.—The horn is easily removed by forceps and scissors, and the base, which will be found soft and bleeding, should be lightly cauterised with the solid nitrate of silver stick.

CHROMIDROSIS—PIGMENTED SWEAT.—A few genuine idiopathic cases have been recorded. The affection is mentioned here because it has generally been about the eyelids and face that the coloured sweat has been noted. The disease causes no subjective symptoms, and simply consists in the fact that over the affected area the sweat excreted

is tinged of a black or dark blue hue. The cases have mostly occurred in women of a very pronounced neurotic type, and in some instances, at any rate, the genuineness of the symptoms has been open to grave doubt. Chromidrosis of a green hue has been also known to occur amongst workers in copper, and the absorption of some other chemicals may, under exceptional circumstances, be followed by coloration of the sweat.

XANTHELASMA PALPEBRARUM.—This affection consists of buff or yellow-coloured patches of the skin, which are most frequently seen on the eyelids near their inner angles. These markings are often placed symmetrically on each side of the face, either above or below the inner canthi, and occasionally they may be seen on the upper and lower eyelids of both eyes. The patients who are thus affected are nearly always beyond middle age, and mostly females, never children.

We have recently met with a lady in whom the xanthelasmic patches appeared to have been hereditary. Her father suffered from the affection, and her two sisters were afflicted in a similar manner.

Hutchinson says that these xanthelasmic patches invariably begin on the left side near the inner canthus. He thinks that they are evidences of past rather than of coming disease, and are most liable to occur in those who have suffered from severe and frequent sick headaches. The late Dr. Addison believed that they were associated with disease of the liver.

Malcolm Morris* has pointed out that xanthelasma sometimes occurs with glycosuria, and this fact should lead to an immediate examination of the urine in every case.

Prognosis.—These yellow patches on the eyelids are perfectly harmless. They may increase in size and in number, but they never produce discomfort, or in any way interfere with the free movement of the lids. When, however, these discolorations of the skin are of large size, they are very unsightly, and on this account they frequently become the source of much mental anxiety.

Treatment.—No local application nor internal administration of medicine will diminish or eliminate these buff or yellow-coloured patches. As a rule it is best to leave them alone, but when they cause great annoyance they may, if not too large, be excised, bearing in mind the danger of producing subsequent eversion of the lids if too much skin is removed.

VACCINIA.—Vaccination pustules are occasionally seen on the lids as the result of accidental inoculation. This occurs through omitting to keep the vaccinated spot on the arm properly protected with dressings; the baby scratches the arm and then rubs the eye; or the mother, as we have known it, becomes inoculated through the baby's arm brushing against her face whilst she was carrying it on her arm.

The eruption runs the usual course, and will be recognised without difficulty unless the pustule has become infected and the case is not seen until an impetiginous ulcer has formed, as may happen. The history and enlargement of the pre-auricular gland may then help the diagnosis.

* Allbutt's 'System of Medicine,' vol. viii, p. 895.

Treatment.—Cleanliness and mild aseptic dressings are all that are needed.

HERPES ZOSTER OPHTHALMICUS—HERPES ZOSTER FRONTALIS.—As its name implies, it is the ophthalmic division of the fifth nerve that is affected in this variety of herpes, and it deserves special consideration, as it is occasionally mistaken for erysipelas of the head, and the eye itself is frequently involved during the attack.

Herpes ophthalmicus is *always unilateral*. It occurs but once in a lifetime, and it has been generally stated that the old are more liable to be attacked than the young. The reverse, however, seems to be the real case, and Head,* in an analysis of 378 cases of herpes zoster, shows that 283 occurred in patients under twenty-five years of age, as against twenty-nine cases in which the patients were over fifty years; whilst the largest proportion of cases occurred between the ages of four and fourteen years.

Symptoms.—The affection, which is ushered in by general malaise, frequently accompanied by some rise in temperature, first shows itself by the formation of small red patches, which appear in succession upon the brow and forehead of one side of the head, and upon which transparent vesicles rise. When the eruption is fully developed, it consists of clusters of vesicles on bright red erythematous patches, with portions of more or less clear skin between them. These patches usually follow the course of the branches of the supra-orbital division of the frontal nerve over the upper eyelid, brow, and one side of the head, but occasionally vesicles will appear in the direction of the terminal branches of the supra-trochlear nerve, and on the side of the nose in the line of the nasal twig from the ophthalmic nerve. After a few days the vesicles begin to wither and collapse, the fluid within them grows turbid, and they become covered with dark crusts, which shortly fall off, leaving scars and pits which are frequently permanent. There is usually some œdema of the side of the face, and the eyelids may be so swollen as to render an examination of the eye impossible.

The eye is especially apt to become affected when the nasal branch of the ophthalmic nerve is involved (Hutchinson), and generally at about the time when the vesicles are beginning to fade. The inflammation may be limited to the conjunctiva; but more frequently it spreads to the cornea, upon which vesicles appear, and ulceration sets in accompanied by severe iritis, which in the worst cases may go on to panophthalmitis with complete destruction of the globe. In a few instances paralysis of some of the extrinsic muscles of the eye has occurred, and still more rarely this has amounted to complete ophthalmoplegia externa.

The duration of the actual skin manifestation is from ten to twelve days; but the inflammation of the eye which it has excited may last for many weeks, and be the source of much anxiety and trouble. The pain, which is neuralgic in character and as a rule is most marked in elderly patients, is usually very severe, and often continues for an

* 'System of Medicine' (Allbutt), vol. viii, p. 617.

indefinite period extending to many weeks after the eruption has subsided.

During the inflammation the skin is apt to be very hyperæsthetic, so that the patient shrinks from the lightest touch; whilst in the later stages, if there is much cicatricial formation, areas of anæsthesia more or less complete may appear. In bad cases the skin may become permanently altered in character; in places becoming furrowed and pigmented, whilst in others, dense white cicatrices are formed, giving a mottled appearance quite characteristic of the affection. In one bad case reported by Holmes Spicer,* which occurred in a boy aged ten years, the scars underwent keloid changes, and in another which came under our own observation there was complete absence of sweat secretion over the area supplied by the supra-orbital nerve.

Diagnosis.—This is usually straightforward; but the disease may be mistaken for erysipelas. The strictly unilateral character of herpes, which is always limited by the median line, sometimes as sharply and directly as though cut by a knife (*see* Fig. 211), is very characteristic. The pain is usually much greater in herpes, and the vesicular nature of the eruption a much more regular and prominent feature in it than in erysipelas. From eczema, herpes may be distinguished by the absence of itching and by its regular distribution; whilst vesicular syphilides are recognised by their irregular grouping, peculiar pigmentation, the absence of pain or severe constitutional disturbance, and by the history or other evidence of syphilis.

Treatment.—The objects to be accomplished during the progress of the disease are to relieve the heat and irritation of the affected parts, to give ease to the neuralgic pains, and to procure sleep. A fold of lint wet with boracic lotion, to which a little cocaine may be added (F. 37), or the Lotio Plumbi (F. 49), or the Lotio Opii (F. 48), may be laid over the surface, and moistened as often as it becomes hot or dry. Opium should be administered internally, either in small repeated doses or in one full dose sufficient to procure sleep at bedtime. The subcutaneous injection of morphia is of great service, and may be given in doses of from gr. $\frac{1}{4}$ to gr. $\frac{1}{3}$, and repeated if the suffering is severe. The bowels should be acted on by some mild purgative, and quinine in doses of from gr. j to gr. iij ordered two or three times a day.

If the conjunctival sac is affected, it should be washed out twice or thrice daily with some weak soothing lotion. Corneal ulceration



FIG. 211.—Appearance of a patient after recovery from a bad attack of herpes frontalis. The affected area is seen to be sharply limited by the median line. The skin is densely white in places, which gives it a mottled appearance.

* 'Trans. Ophth. Soc. U. K.,' vol. xii, p. 220.

must be treated by warm fomentations, atropine, and a light compress, avoiding the use of irritating lotions or drastic applications, such as the cauterly or carbolic acid, because the ulceration is an atrophic and not an infective process. Atropine should be used early and assiduously on account of the severe iritis which is nearly always present with the ulceration of the cornea.

For the relief of the neuralgic pains which are often so persistent after the rash has completely passed away, the painful parts may be gently rubbed with the Liniment. Aconiti (F. 29), and the tinct. cannabis indicæ in doses of from $\text{m}\nu$ to mxv may be prescribed two or three times a day, with an opiate or subcutaneous injection of morphia at bedtime if the neuralgia is sufficient to prevent sleep.

If all remedies fail, the supra-orbital nerve may be divided subcutaneously. Unfortunately, however, the relief from this operation is very often only temporary, but it may be repeated, or a piece of the nerve may be excised. The patient should be cautioned that if the operation is successful, there will be numbness in the parts supplied by the nerve.

TUMOURS OF THE LIDS.

DERMOID CYSTS occur usually in two localities—at the upper and outer margin, and at the lower and inner edge of the orbit, just over the nasal process of the superior maxillary bone. They are congenital, and although they often appear to the touch to be superficial and loosely attached, they are in reality placed deeply, lying in a depression of the bone, beneath the orbicularis, and very adherent to the surrounding parts; they are filled with sebaceous matter, and contain numerous fine hairs.

Treatment.—They should be dissected out through a single incision made over the centre of the prominence of the tumour, and in a line corresponding with the curves of the brow or the orbit. Care should be taken to remove the whole of the cyst, as when portions of it are left it will sometimes re-form. The operation, although apparently very slight, is one which often requires considerable neatness and dexterity. In removing the cyst at the lower and inner angle of the orbit, much trouble is frequently experienced from the angular artery or the frontal branch of the ophthalmic being divided, and the consequent brisk hæmorrhage which follows. It is seldom that a ligature is required; pressure with the finger for a few minutes will usually suffice to stop all the bleeding.

CHALAZION—MEIBOMIAN OR TARSAL CYST.—These growths occur as small isolated tumours in the upper and lower eyelids. There may be two or three of them in the same lid, but they are independent growths, and in no way connected. They generally grow to about the size of a small pea, but they will occasionally attain much larger dimensions. To the finger they feel like small shot in the lid; and externally they give a nodulated appearance, which makes the

patient anxious to be rid of them. They vary in consistence and in the character of their contents; in some instances they are filled with a solid or thick gelatinous material, whilst in other cases their contents are either a transparent or semi-opaque curdy fluid, or, if the cyst has been inflamed, there may be pus.

When first noticed, a tarsal cyst is usually small and firm; then, as it grows, it approaches the inner surface of the lid, its contents undergo degenerative softening, and the conjunctiva immediately covering the tumour becomes thinned and of a bluish colour. In this state the cyst may remain for many months or even years without any apparent change, when from some unexplained cause it may inflame and suppurate. When this happens it usually sets up a good deal of irritation in the neighbouring conjunctiva of the lid, which becomes thickened and velvety, and is the source of much discomfort, and if the pus is allowed to make its own exit, the discharge is frequently followed by an exuberant mushroom-like growth of granulation tissue.

Pathology and Ætiology.—Two forms may be recognised: (1) *Marginal chalazion*, which arises in connection with the Meibomian ducts, and which lies along the lid border. This is not so common and does not attain so large a size as the second variety. (2) *Chalazion proper*, which is formed in the substance of the tarsus where the Meibomian follicles are situated. The term cyst as applied to these growths, though still in general use, is a misnomer, because they are not retention cysts of the Meibomian glands or their ducts, as formerly supposed, but benign neoplasms consisting of a small-celled growth identical with granulation tissue. They contain no glandular elements, and their exact connection with the Meibomian follicles has so far not been clearly demonstrated, although it is plain that they are directly associated with the latter in some way. A curious feature in them is the presence of large multinucleated giant-cells, which resemble those of tubercle, but are not surrounded by any system of epithelioid cells. They are to be found scattered singly or gathered into small isolated groups (Fig. 212).

The ætiology of chalazia is also obscure; they are certainly most apt to appear in people who suffer from chronic inflammation of the palpebral conjunctiva, and many of the patients are of a gouty diathesis; but in very many cases no cause can be assigned. They may occur at any age, and we have frequently seen them in young infants: in some

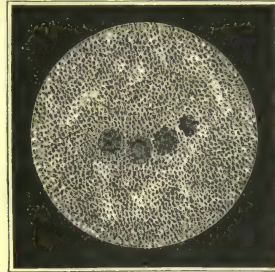


FIG. 212.—Microscopical section of a chalazion, showing multinucleated giant-cells.

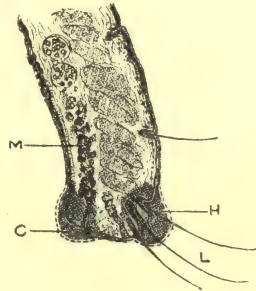


FIG. 213.—Diagrammatic section of an eyelid, showing the different sites occupied by hordeolum and marginal chalazion.

(H) Hordeolum. (C) Chalazion. (L) Cilia. (M) Meibomian glands.

cases patients are never troubled again after the first growth has been removed; whilst in others fresh growths appear at indefinite periods, and in others again they come in a succession of small crops.

Diagnosis.—Inflamed marginal chalazia are sometimes mistaken for hordeola. The differential diagnosis can be determined by observing the exact situation of the growth, which in the case of hordeolum always surrounds the cilia and points towards the external margin of the lid border, whilst the inflammation caused by a marginal chalazion is most marked at the inner margin away from the lashes (see Fig. 213).

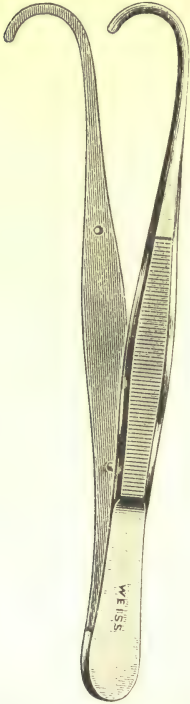


FIG. 214.—Graddy's forceps.

These are very useful in localising small chalazia. One blade is passed under the lid so that the chalazion is contained between the blades.

Treatment.—When the chalazion is very small and shotty, it is no easy matter to get rid of it, and if it causes no discomfort and no obvious disfigurement it is as well to leave it alone. It is productive of no harm to the patient, and can be more easily and thoroughly dealt with at some later date, should it increase in size or become inflamed.

The best time for operating on a tarsal cyst is when the conjunctiva covering it looks thin and bluish, as its contents are then more easily turned out than at an earlier stage of the disease. The surgeon, standing behind the head of the patient, who is seated on a chair, should with one finger evert the lid, and with a Beer's knife make an incision through the length of the conjunctival wall of the tumour in a line parallel with the tarsal margin; if the tumour is large, another smaller incision may be also made through it at right angles to the first. With a fine scoop the whole of the contents of the growth are then to be evacuated, and this is best done by giving to the scoop a slight rotatory movement, which helps to break up the material and to set up sufficient inflammatory action to cause the obliteration of any that is left behind.

In cases of large chalazia it is as well for two or three days succeeding the operation to pass a probe along the line of the incision to prevent the lips of the wound uniting before the cavity is closed.

When the contents of the chalazion are so solid that the whole cannot be shelled out, it is a good plan to apply to the interior of the sac a probe charged with nitrate of silver; free suppurative action will be thus induced, and in all probability a cure will be effected.

It happens on rare occasions that the material of a breaking-down chalazion makes its way towards the skin, under which it points, instead of towards the conjunctiva, and in such a case it may be advisable to effect the discharge of the contents by an opening in the skin made

along the long axis of the lid instead of by the usual conjunctival method.

No attempt should ever be made to dissect out a chalazion. The exuberant granulation which sometimes follows the discharge of a chalazion should be treated by snipping it off with scissors followed by the application of the mitigated nitrate of silver stick to the base.

When the chalazion is small and difficult to fix, Graddy's forceps (Fig. 214) are very useful; one blade being passed along the inner and the other along the outer surface of the lid, so as to enclose the chalazion and adjacent portion of the lid within its curve. Another advantage of these forceps is the complete control over the bleeding that is obtained by the pressure of the blades.

NÆVUS OF THE EYELID may be limited to the skin, or it may include the whole thickness of the lid, and extend through the palpebral cartilage. Sometimes it is an extension of a similar but larger growth within the orbit, with which it freely communicates.

Treatment.—In treating nævi of the lid it is of great importance to avoid destruction of healthy skin, lest a bad ectropion should follow the means adopted for the cure of the disease. A small superficial arterial nævus may be often dissected out; or it may be destroyed by the actual cautery, using the finely pointed cautery made specially for eye purposes, with which the nævus may be touched at two or three points. Where the growth extends more deeply, one or two threads soaked in a strong solution of the perchloride of iron may be drawn through it, and be allowed to remain until suppuration has commenced, when they should be removed. The use of setons, however, has been generally abolished, and a better and very efficient way of treating a nævus of the lid is by electrolysis. From seven to ten cells of the constant current battery will be sufficient. The positive needle is to be introduced into the substance of the nævus at one extremity and the negative at the other, and held in position until a visible change has begun to take place in the nævoid tissue, which is indicated by hardening and a change of colour. If the nævus be large, the points of the needles may be shifted to other parts of the growth at the same sitting. Two or more applications at intervals of from one to three weeks may be necessary to completely obliterate the nævus.

When the nævus is too large to be dealt with in any of the ways mentioned, it must be ligatured. The plan recommended by some surgeons of injecting nævi with solutions of iron or of tannin is dangerous to life, and should not be practised. There are several cases on record where this mode of treatment has terminated rapidly in death.

RODENT ULCER OF THE EYELID.—This generally commences as



FIG. 215.—Sharp scoop for eviscerating the contents of a chalazion.

a small pimple in the skin near the tarsal edge, which ulcerates, and then scabs over, but does not heal. The granulations of the ulcer are small, the secretion from it is slight, and there is no fœtor. It usually

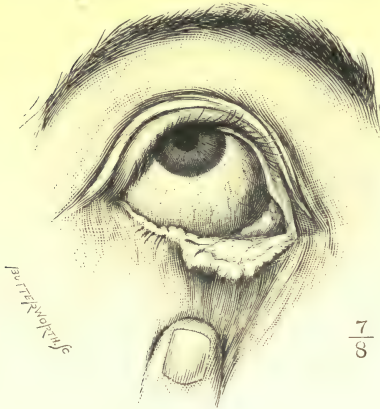


FIG. 216.—Rodent ulcer of the lower eyelid.

gives little or no pain; indeed, the attention of the patient is often called to it for the first time only by a sense of itching, which causes him to scratch it with one of his finger-nails; and to this scratch is frequently attributed the after-progress of the disease. Examined between the fingers, the ulcerated surface will be found to have a hard base and margin. It is not simply an ulcer, but it is a new growth or infiltration in the skin, which induces ulceration of the surface as fast as the deposit takes place. In its onward slow creeping progress more skin is involved, and the dimensions of the ulcer are increased; but repair does not follow

destruction; there is no true cicatrisation in rodent ulcer, although here and there parts of the wound may be imperfectly scabbed over.

Rodent ulcer does not affect lymphatic glands, and it generally attacks the parts of the face above the mouth.

EPITHELIOMA OF THE EYELID is rare as a primary affection. In its early stages epithelioma bears a resemblance to rodent ulcer; but in the later periods of the disease there is a marked distinction between them. Epithelioma invades the lymphatics, and involves the neighbouring glands, which subsequently inflame, contract adhesions to the skin, and ulcerate.

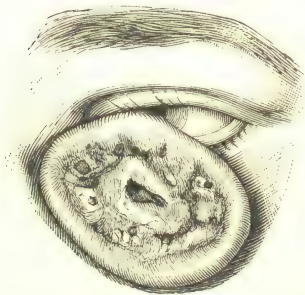


FIG. 217.—Epithelioma of the lower eyelid.

Differential diagnosis between rodent ulcer and epithelioma.—Rodent ulcer does not affect lymphatic glands, whilst epithelioma does, and often at an early stage of the disease.

Rodent ulcer is of slow growth; its malignancy is purely local, and it only destroys life by the infiltration of vital parts. Epithelioma is of much more rapid growth, and its malignancy is general, destroying life by the means of secondary

deposits and the onset of general cachexia.

¶ Rodent ulcer is a rather dry ulceration with only little secretion and no fœtor, and the granulations are small. In epithelioma the secretion from the ulcerated surface is abundant and fœtid, and the granulations large, exuberant, and often in bosses.

Rodent ulcer is usually confined to the upper part of the face, and *always* starts in the skin; whilst epithelioma, although it has a preference for certain localities, as where skin joins mucous membrane, may, under certain conditions, attack any part of the body where there is epithelium.

Treatment of Epithelioma and Rodent Ulcer.—Excise the whole of the disease, carrying the incision into the sound skin, so as to be certain that none of the morbid growth is left behind. If there is any suspicion of the involvement of the pre-auricular gland in epithelioma, it should be removed, together with any infiltrated glands in the neck, although in the latter case there is but small hope of completely extirpating the disease. The chloride of zinc paste (F. 6) may be used with advantage when thorough removal by the knife alone is impracticable, and it should be employed by spreading it on fine lint or linen, which should be applied to the part and left in contact with it until the slough which it produces has separated. Lately the exposure of rodent ulcer to the X rays has been tried, and already several very brilliant results have been recorded. In one case that has come under our observation this treatment was speedily followed in places by the formation of healthy granulations, though sufficient time has not elapsed to allow of any dogmatic assertion as to the lasting nature of the benefit.

LYMPHANGIOMA, which may originate in the orbit, forms a doughy elastic and diffuse swelling much resembling a venous nœvus, but not blue in colour nor variable in size. If the palpebral conjunctiva is infiltrated there will be a translucent jelly-like thickening with perhaps definite vesicular formations in places. Electrolysis offers the best chance of amelioration.

Other rare forms of tumours which need no special description are **Plexiform Neuroma**, **Enchondroma**, and **Adenoma** of the lid glands. The lids may also be invaded by **Leprosy**, **Lupus**, or **Elephantiasis**.

PARALYTIC AND SPASMODIC AFFECTIONS OF THE EYELIDS.

PTOSIS, or a drooping of the upper eyelid over the eye, may be due—

a. To acquired paralysis of the third nerve, or to that branch of it which supplies the levator palpebræ muscle.

b. To paralysis of the cervical sympathetic, which supplies Müller's muscle.

c. To injury of the levator palpebræ.

d. To congenital paralysis of the levator palpebræ.

e. Slight ptosis may be occasionally met with in old people, apparently dependent on a redundancy of wrinkled integument.

f. It may also follow extensive and long-continued trachoma, from thickening of the lid, which droops on account of its increased weight.

Ptosis may be either *complete* or *partial*. In the former the greater part of the cornea and the whole of the pupil is covered by the lid, which cannot be raised by the will of the patient; in the latter the

pupil is only partially hidden, and the lid can be slightly uplifted by a strong effort. Ptosis due to paralysis of Müller's muscle is always partial.

Ptosis from injury may be induced by a wound of the upper lid, lacerating the levator palpebræ muscle so as to impair its function.

Treatment.—In recent cases of ptosis arising from paralysis of the third nerve, or of the filament of it which goes to the levator palpebræ, the course of treatment recommended for paralytic affections of the ocular muscles (page 408) must be followed. If, however, medicinal agents fail, relief must be sought from some operative proceeding. For congenital and traumatic ptosis, none but operative measures are of any use. No form of treatment is likely to avail in the slight deformity caused by paralysis of the cervical sympathetic, whilst for the ptosis which results from trachoma we must rely on the effective treatment of the disease itself.

In deciding on an operation for ptosis, it is a question what amount of drooping of the lid will render surgical interference advisable. Our own feeling is, that if the paralysis is partial and, without any effort on the part of the patient, half the pupil is exposed, no operation should be performed. If, however, the palsy is complete, or only a portion of the pupil can be uncovered by a great effort, or the patient is obliged to throw the head back in order to see objects in front of him, operative measures should be undertaken.

Most of the various operations for ptosis are based on the one endeavour to place the upper lid under the action of those fibres of the occipito-frontalis which are mingled with the orbicularis. They are, however, apt to be disappointing in their final results; for a time the deformity seems

remedied, but in a large number of cases the drooping of the lid gradually reappears to some extent.

Until recent years the usual procedure to relieve ptosis was the shortening of the lid by the excision of a piece of skin and a horizontal strip of the orbicularis muscle (**von Graefe's operation**). This method has been now almost entirely given up on account of its unreliability; either too little is removed to relieve the ptosis, or if so much is taken away that the lid is sufficiently elevated, the patient is unable to close the eye.

Hess's Operation (Figs. 218, 219, 220).—The following is quoted from Lawford's* description of the operation, with a slight modification as to the method of introducing the sutures:—"The eyebrow having been shaved, a curvilinear incision is made in its whole length through the skin and subcutaneous tissue (c c). Starting from this incision, the skin of the upper eyelid is separated from the orbicu-

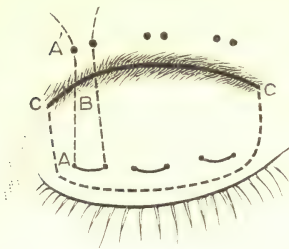


FIG. 218.

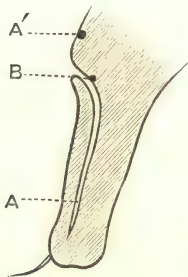


FIG. 219.

* 'Ophthalmic Review,' vol. xiii, p. 76.

laris, the dissection being carried down nearly to the ciliary margin, and practically along the whole length of the lid. Three silk sutures, each armed with two needles, are then passed from without inwards, through the skin only, and close to the lid margin at A (halfway between the eyebrow and the lid margin [Hess]), and are brought out at B in the space made by the previous dissection. The three sutures should equally divide the length of the ciliary border, the middle one being placed centrally, and each forming a loop about 5 mm. in length. When the stitches are pulled upon, the skin of the upper lid becomes folded upon itself, the fold corresponding fairly accurately to that normally present in the lid. The needles are now passed deeply under the upper border of the incision in the brow and brought out at A', a few millimètres above it. The two ends of each thread are now tied over a piece of small drainage-tube, the amount of traction necessary being gauged before the knots are made fast, and finally the brow incision is united by a continuous suture. The stitches are left in from eight to ten days, and can, if necessary, be tightened from time to time."

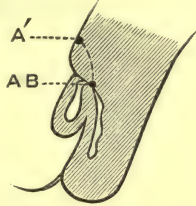


FIG. 220.

A great cosmetic advantage is gained by this operation, in that it reproduces very perfectly the obliterated oculo-palpebral fold and gives a most natural appearance to the eye; and further, owing to the large cicatricial surface obtained by undermining so extensive an area of skin, there seems to be less tendency for the ptosis to reappear.

Panas' Operation (Fig. 221).—A flap of skin and muscle is made in the following way. An incision one inch in length is made down to the bone along the centre of a line corresponding to the upper orbital margin, and another, involving skin and orbicularis only, along the line of the oculo-palpebral fold; this latter incision being left uncompleted centrally for a space of 8 mm. The first and second incisions are now joined by two vertical cuts, marking off the central space into a rectangular flap, which is dissected right up to the ciliary border, and contains orbicularis as well as skin tissues. A third incision, extending down to the bone and about $1\frac{1}{4}$ inches in length, is made just above the eyebrow, and the intervening tissues between it and the incision along the orbital margin undermined, so as to form a bridge. Under this the cutaneous flap is slipped, and is attached to the upper margin of the highest incision by means of three sutures (A A A) passed in the manner shown in Fig. 221. The eyelid is thus pulled up by its central flap; but if left like this there would be

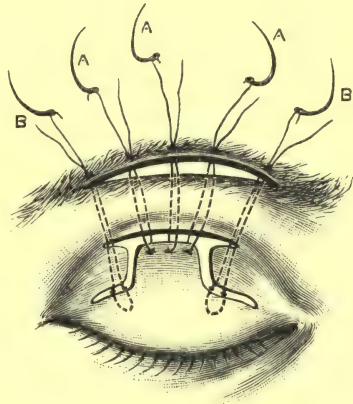


FIG. 221.

considerable danger of ectropion and peaking of the lid, and to prevent this two lateral buried sutures (B B) are passed, one on each side as in Fig. 221, so directed that they engage and drag upon a loop of the suspensory ligament and conjunctiva, but do not emerge upon the skin.

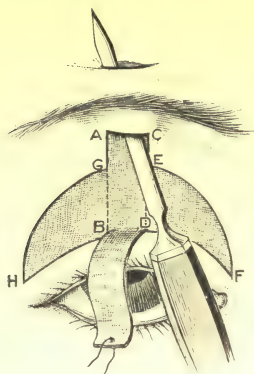


FIG. 222.

orbicularis muscle embraced within these cuts is then carefully dissected off, leaving the whole tarsal cartilage denuded of tissue. The

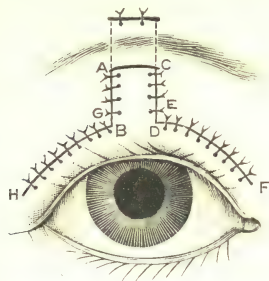


FIG. 223.

Tansley's Operation.—This is an ingenious modification of Panas' and von Graefe's operations, and is performed as follows (*see* Figs. 222, 223):—"Two perpendicular and parallel cuts (A B, C D) are made $\frac{1}{4}$ inch apart, which extend from the upper orbital margin to within two lines of the edge of the upper lid. These incisions are united at A C, and the strip of skin dissected up and enveloped, or allowed to lie on an aseptic pad which is moistened with warm saline solution. Curved incisions are then made from G to H and from E to F, following the line of the fold which marks the upper limit of the tarsal cartilage, and then a straight cut is made from H to B and from D to F, parallel to and about two lines distant from the ciliary border. The skin and

orbicularis muscle embraced within these cuts is then carefully dissected off, leaving the whole tarsal cartilage denuded of tissue. The cut edges H G and E F are then to be united respectively to the cut edges H B and D F by fine interrupted sutures.

"A Graefe's cataract knife is then entered at A C, and brought out on the forehead just above the eyebrow, and slight lateral cutting is employed to give room for the passage of the strip of skin which has been dissected up at the first stage of the operation. This strip of skin is then passed up through the subcutaneous incision and brought out on the forehead by means of a suture attached to its upper edge, and when drawn sufficiently

tight it is cut off flush with the forehead, and attached in its new position by two fine sutures. Finally, several sutures are placed between A and G and C and E, to assist in the support of the flap."

PARALYSIS OF THE ORBICULARIS MUSCLE—LAGOPHTHALMOS.—This is usually associated with paralysis of other facial muscles. The symptoms consist of an inability to close the eyelids and, in exceptional cases, even to approximate them. From the old fable that the hare never shuts its eyes in sleep, the affection has received the name of *lagophthalmos*. The lower lid, having lost the support of the orbicularis, falls away from the globe, and the punctum becoming everted the tears flow over the cheek, and the tarsal margins are apt to become excoriated. The most distressing symptoms, however, from a loss of power of the orbicularis arise from the exposure of the

eye, owing to the imperfect closure of its lids, to the contact of foreign particles, and the irritating effects of wind and glare.

Treatment.—This, in recent cases, is the same as that advised for paralytic affections of the ocular muscles (*see* page 408). It is hardly necessary to add that when it occurs as a symptom of middle ear disease, or as a pressure sign in tumours, attention must primarily be paid to such cause of the paralysis.

In severe cases the eye should be protected from exposure by a shade or some other light covering, which should be worn by night as well as by day. If the eye shows signs of suffering from exposure, especially if the cornea in consequence becomes ulcerated, the most efficient method of treatment is to unite the margins of the lids at one or two points with a fine suture after removing a slight paring from the ciliary margins so as to obtain cohesion. If the orbicularis recovers power, the points of union are easily divided, and, in the meantime, the ulceration will probably quickly heal, and the eye will be protected from further contamination. This treatment was successfully adopted in a case reported in the ‘Royal Lond. Ophth. Hosp. Rep.,’ vol. vii, p. 5.

In cases less severe than these, where the paralysis has become permanent and the patient suffers from slackness of the tissues and entropion of the lower lid, the latter should be shortened by Adams’ operation, or by the method designed by Argyll Robertson, or by tarsorrhaphy, all of which will be found described in the section dealing with entropion. It will probably also be necessary to open the lower canaliculus to relieve the epiphora, which is the symptom that causes the most discomfort to the patient.

BLEPHAROSPASM, or spasmodic contraction of the orbicularis, causing the lids to be tightly grasped upon the globe, occurs in all affections of the eye in which photophobia is a prominent symptom. It is caused by some irritation of the fifth nerve, inducing a reflex contraction of the orbicularis.

a. It is met with in severe cases of the purulent ophthalmia of infants, and in most of the diseases of the cornea, especially those which are marked by ulceration. The continued spasm will sometimes cause entropion, by folding in the tarsal margins of the lids. More rarely the violent squeezing of the lids together produces a spasmodic eversion.

b. It frequently occurs in trachoma, when, from spasm of the orbicularis, it is often difficult to evert the lids to treat the granulations.

c. It may accompany the simple hyperæsthesia of the retina which is occasionally seen in anæmia and debility.

d. It is present in most cases of lodgment of foreign bodies in the eye.

e. It may also be associated with neuralgia of the fifth nerve especially of its supra-orbital branch.

The treatment must consist in the endeavour to arrest the spasm by the removal of the source of the irritation. When a foreign body is suspected, the lids should be everted, and the surface of the cornea carefully examined, as if a particle of grit or dust can be detected, the removal of it will at once relieve all spasm.

For the mode of dealing with blepharospasm due to the various affections of the cornea or conjunctiva, the reader must refer to the sections dealing with these diseases. In spasm of the orbicularis arising from anæmia and debility, chronic constipation is often the root of the trouble, and should be treated energetically (*see also* "Hyperæsthesia of the Retina," page 335). The eyes should be protected from exposure to glare by dark neutral-tint glasses, and if the intolerance of light is severe, the suspension of the accommodation for a few days by instilling a weak solution of atropine will often give great relief.

When the blepharospasm is associated with neuralgia of one of the branches of the fifth nerve, quinine should be given in full doses, and the pain relieved by the subcutaneous injection of from gr. $\frac{1}{6}$ to gr. $\frac{1}{3}$ of the acetate of morphia, according to the age and suffering of the patient. If pressure with the finger on the infra- and supra-orbital branches of the fifth nerve will decide which of the two is the cause of the reflex spasm of the orbicularis, that nerve may be subcutaneously divided with a tenotomy knife.

NICTITATION, or a frequent blinking of the lids, is a peculiar nervous affection, in some patients quite involuntary, and in others only to be suppressed by a strong effort of the will. It is sometimes associated with chorea; it then becomes most manifest when the patient is self-conscious. A mild form is peculiarly common in children who have some, usually hypermetropic, error of refraction, and disappears with the prescribing of suitable glasses; whilst in other children it is simply one of the many similar nervous tricks that they are apt to develop, and which are discarded with the onset of puberty. In extreme cases the nictitation may be so frequent and beyond the control of the will as to interfere with all duties that require a close application of the eyes.

Treatment.—Search should be made for any cause of irritation such as refractive errors, and, failing local cause, the state of the various visceral functions should be examined, and any derangement rectified. If there be any suspicion of chorea, the child should be at once placed under treatment suitable for that disease.

ENTROPION, OR INVERSION OF THE EYELIDS.

There are two forms of this disease: (*a*) the **Congenital** and (*b*) the **Acquired**.

a. **CONGENITAL ENTROPION** is a rare condition which has already been mentioned on page 452.

b. **ACQUIRED ENTROPION** is of two kinds:

1. **Spasmodic entropion.**

2. **Cicatricial entropion**, which is dependent on structural changes of the conjunctiva of the lid.

1. **SPASMODIC ENTROPION** is due to a spasmodic contraction of the orbicularis. It may occur after an injury, or during any affection of

the eye which is accompanied by much photophobia and lacrymation, and particularly if the eye has been for some time closely bandaged up.

From the constant overflow of tears, the tarsal border becomes red and excoriated; and from the repeated spasmodic contractions of the orbicularis muscle, the edge of the lid becomes curled inwards—sometimes to such an extent that the eyelashes cannot be seen without first everting the tarsal margin by drawing upon it with the finger. Spasmodic entropion is frequently seen after the operation for cataract, and especially in old people, in whom the skin of the lids is loose and wrinkled. This inversion of the lashes is usually confined to the lower lid.

Treatment.—The best method of treating this form of entropion is to remove a narrow strip of the skin, and of the orbicularis muscle, close up to and nearly the length of the margin of the lid. This is to be done by first pinching up a fold of the skin in a line with the lid by a pair of forceps, and cutting it off with a pair of scissors. A corresponding piece of the orbicularis is then to be seized with the forceps, and excised in a similar manner. No sutures will be required; but when all the bleeding has ceased, the edges of the wound should be gently pressed together, and a light pad of lint or gauze with a bandage fastened over them. Complete union will be effected in two or three days. Treatment by dragging on the skin of the lid by strips of plaster, or by painting with collodion, is generally quite inefficient, except for the slight cases where the entropion is caused by bandaging. Another method of dealing with slight cases of entropion is by Gaillard's sutures (Figs. 224, 225). Each suture forms a loop along the skin surface close to the inverted tarsal border (E), and each thread is passed down beneath the skin to be brought out vertically below its point of entry close to the infra-orbital margin (D). The free ends (A B) are then drawn tight, and in so doing drag upon the ciliary border, which is straightened and drawn away from the globe. They are then tied over a piece of rubber drainage-tube, pinching up a fold of skin (C) by their traction on the lid. Two such sutures are usually introduced, each forming a loop about 5 mm. in length, and dividing the lid border between them. The sutures are left in for a full week, in the hope that some permanent cicatrisation will keep the lid in its new position; but the final results are generally disappointing.

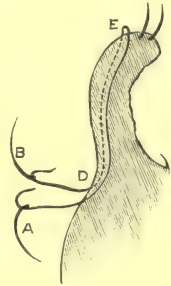


FIG. 224.



FIG. 225.

2. CICATRICAL ENTROPION is caused by purulent and granular ophthalmia; by injuries to the conjunctiva of the lids from hot metal, lime, mortar, or any other escharotic which may have caused a destruction of a portion of that membrane. As cicatrisation proceeds, the contraction of the conjunctiva causes the margin of the lid with its

lashes to become inverted and drawn towards the globe. This folding in of the lashes is a source not only of great discomfort to the patient, but of danger to the eye. The continued brushing of the lashes against the cornea in every movement of the eye is apt to induce a



FIG. 226.—Horn spatula for protecting the globe in operations upon the eyelids.

troublesome form of keratitis with ulceration, and will invariably after a time render the cornea nebulous and vascular.

Treatment.—When the entropion is very severe, and dependent on a thickened and contracted palpebral conjunctiva produced by trachoma, or following on cicatrization due to an injury to that membrane from some escharotic, the only operation which will afford permanent relief is the removal of the entire row of lashes (*see* page 460). Associated with the inversion there is frequently a considerable contraction of the palpebral aperture. When this exists, the external canthus should be first divided with a pair of scissors, and then a fine suture inserted between the divided conjunctiva and the opposite point of skin, in order to prevent the reunion of the edges of the incision. This little operation is known as **Canthoplasty**. There are, however, many cases of entropion due partly to spasm of the orbicularis, and partly to a contraction of the palpebral conjunctiva. For this class, one or other of the numerous operations for everting the infolded tarsal cartilage and rectifying the displaced lashes may be performed.

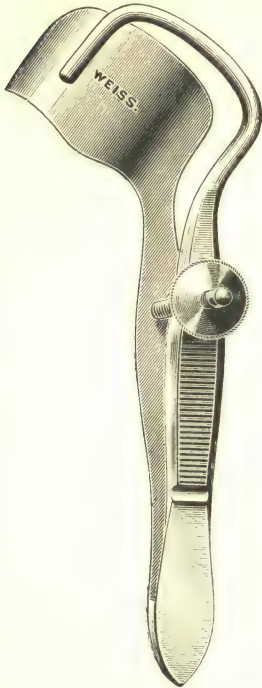


FIG. 227.—Desmarres' entropion forceps (left). The broad blade is applied to the conjunctival surface of the eyelid.

Burow's Operation.—The object of this operation is to restore the inverted tarsal edge to its normal position, and thus to avoid the necessity of removing the row of lashes. In entropion there is an incurving of the tarsal cartilage, so that the cilia brush against the surface of the eye. If such an eyelid be everted, a whitish line will generally be seen running parallel to the margin of the lid, and about one line distant from it; it is upon this line that the tarsal edge is flexed on to the globe.

The operation is thus performed :—The lid is everted, and the horn spatula (Fig. 226) having been placed between the globe and lid, an

incision is made completely through the tarsal cartilage, about one or one and a half lines from its free border, along the white line above mentioned, and extending from the outer to the inner extremity of the tarsal cartilage, taking care to sever thoroughly the cartilage and all the structures of the lid up to the skin, but not to cut the ciliary margin at any point. The lid may now be replaced, and its ciliary border will probably rest against the globe in its proper position, and the operation is completed. If, however, the skin of the lid is very lax, or the tarsal margin is still inclined to curve inwards, a piece of skin may be removed from the lid by pinching a portion of it up with T-shaped entropion forceps, and cutting it off with a pair of scissors. The edges of the wound are then to be brought together with fine sutures.

In dividing the tarsal cartilage the left thumb-nail should be inserted into the incision to keep the lid steady, and the blade of the knife should be held parallel with the tarsal edge so as to avoid making an oblique section of the cartilage.

A simple and very efficacious method of performing this operation is to make at one extremity of the white line which runs parallel with the tarsal margin, a cut with a fine knife through the edge of tarsal cartilage of sufficient size to admit one blade of a pair of scissors. Into this cut one blade of the scissors is inserted, and then, with a few decided snips, the tarsal cartilage is divided along the white line from end to end.

Jaesche-Arlt Operation (Fig. 228).—This is an excellent operation, the principle of which is the transplantation of the ciliary follicles.

A horn spatula (Fig. 226) having been placed under the lid, or entropion forceps (Fig. 227) adjusted, the ciliary margin is split with a Beer's knife along the whole length of the intermarginal space (c), and the anterior flap is to contain all the ciliary follicles. The knife is pointed vertically as in Fig. 228, and care must be exercised not to injure the follicles, and to split the lid sufficiently deeply to isolate them completely from their posterior attachments. Another incision (B), extending down to the tarsus, is now made along the whole length of the lid parallel to its border, and about 3 mm. above it; and this is joined at each extremity by a third incision (A), involving skin only, which marks off an elliptical flap of skin about 6 mm. in width at its widest part. The exact height of this flap is very important, and must be in direct proportion to the severity of the entropion, and it is best regulated as Fuchs* suggests by pinching up a fold of the skin before the operation, and noting the effect produced. If too much skin is removed, the patient may be unable to close the eye afterwards; and if too little, the ciliary follicles will not be removed out of harm's way.

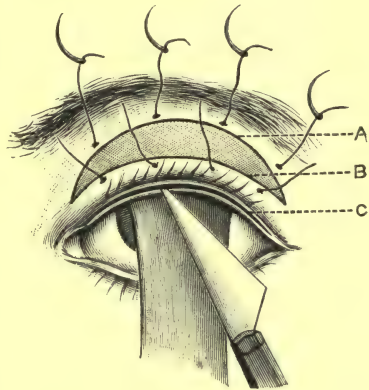


FIG. 228.

* 'Text-book of Ophthal.,' 2nd edit., p. 788.

The intervening flap of skin is now dissected off, leaving the orbicularis undisturbed, and the edges of the gap brought together by a few fine sutures, which should be passed deeply through the lower lip, which contains the ciliary follicles, but only through the skin above. A cleft will be left in the intermarginal space, and as this heals up a certain amount of cicatricial contraction will follow, which will diminish the primary effect of the operation; so that it is wise to shift the cilia a little more than at first appears necessary, and in very severe cases it is a good plan to transplant the piece of excised skin into the intermarginal space, where its attachment will lessen subsequent contraction.

Holtz's Operation.—The lid border having been split as in the previous operation, an incision is made along the whole length of the oculo-palpebral fold, which corresponds to the upper border of the tarsus, and the strip of the orbicularis exposed by the incision removed so as to weaken the action of this muscle. Both lips of the incision are then attached directly to the tarsus by three sutures, each of which is made to pass through its upper border. The effect of this is to drag upon and evert the anterior portion of the split lid border, which contains the ciliary follicles. As in the previous operation, the gap in the intermarginal space may, if considered advisable, be filled in by transplantation of a Thiersch graft or a piece of mucous membrane from the inside of the lip.

Streatfeild's Operation.—The lid is held with Desmarres' forceps (Fig. 227), the flat blade passed under the lid, and the ring fixed upon the skin, so as to make it tense and expose the edge of the lid. An incision with a scalpel is made of the desired length just through the skin, along the palpebral margin, at the distance of a line or less, so as to expose, but not to divide, the roots of the lashes; and then just beyond them the incision is continued down to the cartilage (the extremities of this wound are inclined towards the edge of the lid). A second incision, farther from the palpebral margin, is made at once down to the cartilage, in a similar direction to the first, and at a distance of a line or more, and joining it at both extremities; these two incisions are then continued deeply into the cartilage in an oblique direction towards each other. With a pair of forceps, the strip to be excised is seized and detached with the scalpel; the wound is left to heal by granulations. If an increased effect is thought necessary, the gap in the cartilage may be closed by sutures, which should attach the lips of the skin wound as well; but this suturing of the wound is *not* a part of the operation as designed by Streatfeild.

ECTROPION, OR EVERSION OF THE EYELIDS.

Ectropion may be classified, according to its causation, into—

1. **Spasmodic Ectropion.**
2. **Senile Ectropion.**
3. **Paralytic Ectropion.**
4. **Cicatricial Ectropion.**

1. SPASMODIC ECTROPION most commonly occurs in young children suffering from severe blepharospasm, the result of pannus or corneal ulceration. In all such cases, when the lids are not much swollen, ectropion of this sort may be produced mechanically by attempting to pull the lids apart whilst the child is resisting vigorously; but it may also occur spasmodically without any interference, and it is then a very troublesome symptom, as the lids, when once everted in this manner, tend to remain so, and if replaced the ectropion as constantly recurs again. Patients suffering from Graves' disease are sometimes seized with severe attacks of spasm of the orbicularis, during which the lids may become everted and the globe dislocated, and we remember one case in which this was a cause of great suffering, the patient screaming with agony whilst the spasm lasted.

Treatment.—The lids should be replaced and kept in their proper position by strips of strapping, or by a firm compress and bandage. At the same time, energetic measures should be employed to combat the cause of the blepharospasm, a most effectual method being the application of one or two leeches close to the outer canthus. If this fails, the external canthus should be freely divided with scissors by a horizontal snip (**canthotomy**), which relieves spasm by cutting through the orbicularis, and also does good by causing some free bleeding. The little wound heals in the course of a few days, and the paresis of the muscle is only temporary.

2. SENILE ECTROPION.—This is an affection that only involves the lower lid. In old people there is a general slackening of the tissues, which become flabby and redundant, and the lower lid is apt to lose its normal approximation to the eye and fall forwards. As a consequence, the punctum lacrymale becomes displaced, the tears no longer find their normal exit down the nose, and the patient is constantly under the necessity of wiping the eye, by which he drags on the lid and induces further displacement of it. The loss of approximation between lid and globe also permits the entrance and collection of irritating particles of dust, etc., into the lower conjunctival sac, which set up a chronic inflammatory condition of the conjunctiva and cause increased lacrymation, so that a vicious circle is established by which the lid border becomes more and more everted, and at the same time becomes rounded and thickened by alterations in the exposed portion of its inflamed conjunctival lining.

Treatment.—It is epiphora that brings most of these patients to consult the surgeon, and if we can relieve these old people of their discomfort without subjecting them to any radical operation it is much better to do so, as they mostly care little for the slight deformity caused by the ectropion, and will shrink greatly from the idea of an operation. This we can generally effect by the following means:

If the eversion of the punctum is slight, it may often be brought into place again by one or two applications, at intervals of a few days, of the solid nitrate of silver stick, which, after the application to the part of a few crystals of cocaine, should be rubbed gently over the conjunctiva immediately behind and adjacent to the displaced punctum; but if the

eversion is too great to be remedied in this way the treatment is reinforced by slitting up the canaliculus as far as the lacrymal sac but without opening the latter, so as to make a little gutter along which the tears may flow. In most cases the punctum is found contracted or partially obliterated, and it is always advisable to dilate it and syringe the canal through, not only to ensure its patency, but also because the dilatation of the disused canal does good. There is frequently to be noticed in old-standing cases an excrescence of hypertrophied tissue adjacent to the punctum which hinders the inversion of the lid border, and if this is the case a small portion may be sliced off with a scalpel quite painlessly by touching it first with a few crystals of cocaine; and here, again, the subsequent scar will help to invert the lid.

At the same time, attention should be paid to the rest of the palpebral conjunctiva, which, if inflamed, should be painted twice weekly with a solution of nitrate of silver grs. x ad ʒj, and, during the intervals, the patient ordered to use astringent drops or lotion two or three times daily (F.F. 26, 54). Lightly tinted neutral protectors should be worn out of doors, and the patient instructed as to the method of wiping his eyes, namely, to do so by passing the handkerchief from below upwards, and so to push the lid towards the eye instead of dragging it downwards.

A few cases will remain in which the ectropion is too severe to allow of relief being obtained by these means alone, and in them the best method of procedure is to shorten the lid by **Tarsorrhaphy**, or **Adams' operation**, or by **Argyll-Robertson's operation**, all of which are described in dealing with cicatricial ectropion.

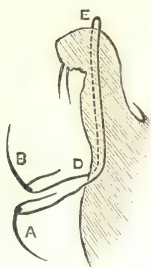


FIG. 229.

Snellen's Sutures (Figs. 229, 230).—These may be mentioned here as an useful means of obtaining temporary inversion of the lid or an adjunct to the treatment of senile ectropion. They are passed in the following way, and two is the number usually employed.



FIG. 230.

Each suture is needled at both ends. One needle is passed obliquely through the lid from within outwards, being made to pierce the conjunctiva at the spot where the lid begins to curl away from the eye (E), and is brought out on the skin opposite the infra-orbital margin and vertically below its site of entrance (D). The second needle is passed in a similar manner parallel to the first and at a distance of about 5 mm. The two needles of the second suture are passed in precisely the same way at about the distance of 5 mm. from the first suture, so that the two sutures roughly enclose the central half of the lid, or a space of about 15 mm., where the ectropion is most marked. By drawing in the free ends of the sutures the conjunctival loops are tightened, the effect of which is to straighten the lid border. As soon as the requisite effect has been produced, the free ends are tied

over a piece of drainage-tube and so left for four or five days. The passing of these sutures is very painful, and they cause considerable discomfort. They set up a certain amount of irritation and cicatrization, which tends to hold the lid in its new position when the sutures are removed; but the ultimate results as a cure for eversion are very disappointing, for as a rule the effects gradually diminish, and may in course of time entirely disappear.

3. PARALYTIC ECTROPION.—The symptoms are similar to those seen in senile ectropion.

Treatment.—The same as for senile ectropion. In cases of complete palsy of the orbicularis some operation to shorten the lid will almost certainly be necessary.

See also "*Lagophthalmos*," page 474.

4. CICATRICIAL ECTROPION.—In this, the worst and most intractable variety, the ectropion is the result of injury or of some disease associated with the formation of cicatrices. In all except very slight cases, the eye having lost a part of its natural protection is liable from undue exposure to attacks of recurrent inflammation of its conjunctival lining, and, as in senile ectropion, epiphora is a very annoying symptom when it is the lower lid that is affected. In cases of long standing, the conjunctiva becomes much altered in appearance and character: in some instances it becomes almost cuticular; in others, again, so hypertrophied and granular as to acquire somewhat the look of a fungoid excrescence.

Cicatricial ectropion may be produced—

a. By the cicatrization following the destruction of a part or the whole of the skin of the eyelid from burns, scalds, and escharotics.

b. By the cicatrization of a wound in the neighbourhood of the eyelids.

c. By abscesses in the cellular tissue at any point near the margin of the orbit, and especially if associated with diseased bone.

d. By the cicatrization following lupus. Both lupus exedens and non-exedens will cause very severe ectropion.

If the wound be in the vicinity of the orbit, the contraction which accompanies the healing process draws upon the tarsal edge of the lid, and gradually everts it. This contraction of the neighbouring skin towards the seat of the injury is not confined to the actual period of cicatrization, but continues for many months afterwards, increasing the extent of the ectropion, whilst it diminishes the size of the cicatrix.

When the ectropion is caused by an abscess near the margin of the orbit, very little if any of the skin may have been involved in the supuration. The ectropion is then dependent on a portion of the cellular tissue having been destroyed by sloughing, and the skin becoming drawn and adherent to the parts beneath, instead of gliding smoothly over them. With the contraction of the skin towards the cicatrix, a pull is exerted upon the eyelid, which will first draw the tarsal edge up or down as the case may be, and then gradually evert it.

Two forms of ectropion may be recognised, either of which may be produced by the same cause, the difference being only in degree.

1. Where there is a *partial* eversion of the eyelid, with a thickened and fungoid condition of the conjunctiva.

2. Where the eyelid is *entirely* everted, its conjunctival surface being completely exposed.

The first form is most frequently caused by the cicatrisation of a wound in the neighbourhood of the eyelids; whilst the second is generally the result of an absolute destruction of a portion or the whole of the skin of the lid itself.

Treatment.—This will be described in the order in which it would be wise to proceed in treating the defects caused by cicatricial ectropion.

1. **If the punctum lacrymale be displaced**, and drawn away from the globe, the canaliculus should be slit up so as to convert it into a canal along which the tears may flow into the sac. It is best not to open the lacrymal sac unless there are indications of a stricture.

2. **If the exposed conjunctiva is much thickened and hypertrophied**, the prominent fungoid-looking portion should be excised. This is most easily done by seizing hold of the piece of conjunctiva which is to be removed, with a pair of fine-toothed forceps, and cutting it off with a pair of small scissors curved on the flat. The contraction which accompanies the cicatrisation of the conjunctiva draws the edge of the eyelid inwards, and helps very materially to restore it to its natural position.

3. **If the tarsal edge of the lid is elongated**, it must be shortened before the lid can be restored to its proper position. This lengthening of the tarsal margin is due to the constant pull which has been exerted upon it during the contraction and cicatrisation of the wound which has caused the ectropion. To remedy this defect a V-shaped piece of the edge of the lid (as in Fig. 231) may be excised with a fine scalpel (**Adams' operation**). The lips of the wound are then to be brought together with fine pins or with simple sutures, taking care that one of the sutures is inserted close to the tarsal edge (as in Fig. 232), so that an accurate apposition of the corresponding surfaces is secured. A portion of the tarsal margin may thus be removed from any part of its length; but in most cases it is advisable to make the excision from the extreme end close to the outer canthus. The edges of the wound are brought more easily and accurately together than when the part excised is near the centre of the lid, and the scar which is left is much less noticeable.

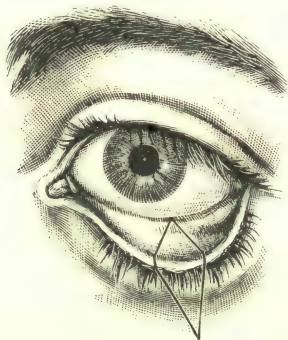


FIG. 231.

If the elongation is slight, so that it is not considered advisable to excise a portion of the lid, the palpebral aperture may be shortened at the outer canthus by paring the margins of each lid to the extent required and cutting

sufficiently deeply to remove all the cilia within the lines of incision, after which the raw surfaces are approximated by sutures. This operation is known as '**Tarsorrhaphy.**'

4. **To relieve the eversion of the eyelid** many operations have been suggested and practised. The following is a brief account of some of the operations for ectropion, and the conditions upon which they may be performed.

A. **Where there is a Complete or Partial Eversion Dependent on a Cicatrix at a Short Distance from the Lid.**—For convenience of description we will consider a case in which the lower lid is the one affected; the same plan of treatment, modified according to circumstances, will be applicable to ectropion of the upper lid.

If the ectropion is *partial*, and due to a small cicatrix which is only adherent to a very limited area of the cellular tissue beneath it, while around the scar the skin will glide easily over the subjacent tissues, it will be sufficient first to free the deep adhesions of the cicatrix by subcutaneous division. A tenotomy knife is to be introduced beneath the integument, at a short distance from the scar, and by a few semicircular sweeps the union between it and the cellular tissue will be parted. If this is satisfactorily accomplished, the skin will glide with freedom over the parts to which it was before adherent. The tarsal edge of the lid should now be shortened in the manner already described; and if the exposed conjunctiva is much thickened, a portion of it also should be excised. By these means the lid will be restored to its normal position, and as the scar will be lifted from its original site, the chance of its reuniting to the parts from which it has been severed will be diminished.

In the daily dressing of the wounds, the lids should be well supported with a pad of lint, to prevent the cicatrix being again drawn down to its former position.

B. **If the ectropion is severe, and the cicatrix which has caused it is dense and firmly attached to the subjacent parts,** a different proceeding must be adopted. One excellent mode of treatment, sometimes known as "**Wharton Jones' operation,**" is to include the cicatrix in a V-shaped incision, which is to be separated by a few strokes of the scalpel from all its adhesions to the underlying parts, as is well shown in Fig. 233.

The triangular-shaped piece of skin in which the cicatrix is included is then to be pushed upwards, whilst the lower edges of the V wound are united by two pins and twisted sutures, in the situation marked by the dotted lines in Fig. 233, so as to convert

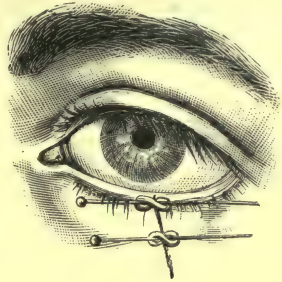


FIG. 232.

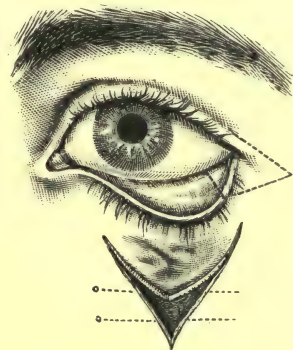


FIG. 233.

the **V**, when the parts are brought together, into a **Y**. The everted lid will thus be raised; but in order to keep it in position, its tarsal edge should be shortened at the outer canthus, removing at the same time a small piece of the margin of the upper lid, to which the lower one should be united by pins and twisted sutures. If the conjunctiva is much thickened, a portion of it may be excised before shortening the lid. Simple sutures can be employed instead of the pins if preferred.

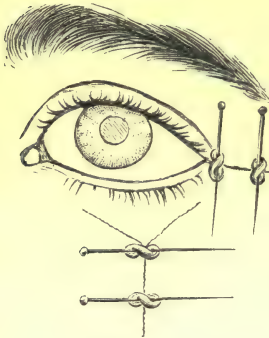


FIG. 234.

Fig. 234 shows the appearance the eye will present after the operation is completed.

Argyll-Robertson's Operation for Ectropion of the Lower Lid.—The following description is given in the author's own words:—

“The operation consists in making an incision through the skin of the outer third of the lower lid, parallel to and about a line (2 mm.) distant from its margin. When the incision has been carried as far as the outer canthus the knife is directed a little more upwards, and the incision continued for about half an inch. It is then carried horizontally outwards for about three lines (6 mm.), and, lastly, downwards and inwards, nearly parallel to the upward incision, but diverging a little from it below, for the distance of about an inch and a quarter. Fig. 235 indicates the course of the incision.

“The flap of skin thus outlined is then dissected from subjacent parts, and reflected back as shown in Fig. 236.

“Next, a suitable **V**-shaped portion of the whole substance of the lower lid is removed at a little distance (say 3 mm.) from the outer

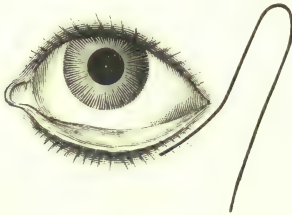


FIG. 235.

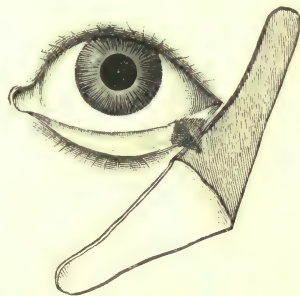


FIG. 236.

canthus. The ‘strap’ of skin which has been reflected is now drawn upwards and outwards till the edge of the lid is brought up to its natural position, and the skin which it then overlaps is outlined by bringing the knife along the edge of the strap, and the portion thus outlined dissected off. Lastly, the ‘strap’ is replaced and fixed in position by several sutures, as seen in Fig. 237.

“It is advisable not to remove a large **V**-shaped portion of the lid at

first, as a little more can easily be snipped away if, on drawing the lid into position by means of the 'strap,' a puckering of the edge of the lid indicates that too little has been removed.

"This operation is particularly useful in senile ectropion or in eversion of the lid from long-continued palpebral conjunctivitis, when the free edge of the lid has by traction been elongated and the curvature of the tarsal cartilage altered, but it may be advantageously employed in other forms of ectropion also.

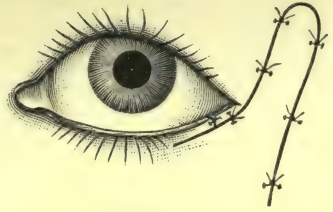


FIG. 237.

"The chief advantages I have found in this method of operating are—(1) that the exact amount of lid tissue that should be removed is easily ascertained; (2) that by means of the strap of skin very efficient and permanent traction on the lower lid is obtained, thus bringing it and fixing it in proper position.

"Instead of removing the skin that lies under the strap when it is drawn up so as to bring the lid into position, a small portion of the extremity of the strap might be cut off, and the effect would be similar. But I prefer the method described, giving as it does a larger surface on which to fix the strap."

Dieffenbach's Operation.—The cicatrix is first dissected out by including it in a triangular incision (Fig. 238), the base of which corresponds with the tarsal margin of the lid. Having removed this triangular flap of skin, the cut (*cc*) is then extended to *ca*, *ca*, to allow of the ready approximation of the sides *bb*, which, having been first raised from the subjacent parts by a few strokes of the scalpel, are brought together and united by sutures as in Fig. 239. The two lateral incisions (*ca*, *ca*) are then fastened by sutures to the integument beneath the lower lid in the line *cc*.

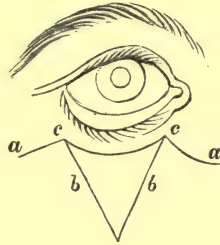


FIG. 238.

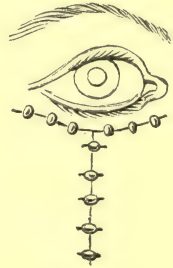


FIG. 239.

Fig. 239 represents the appearance after the operation has been completed.

c. In those cases where **much of the integument of the eyelid has been destroyed**, and **complete eversion** of it has followed, it is seldom that the lid can be permanently restored to its natural position without some plastic operation (**Blepharoplasty**). After the lid has been dissected from the adhesions which bind it down, and has been replaced over the eye, a large granulating surface will be left, which, unless covered over by new skin borrowed from a neighbouring part, will cause a return of the ectropion during cicatrisation.

It is undesirable and confusing to describe all the many different operations that have been either suggested or performed for the making of a new eyelid. Each case presents peculiarities of its own,

for which no special directions can be given. The result of the operation depends very much on the ingenuity of the surgeon in designing one fitted for the case, and on his dexterity in carrying out neatly the details which his mind has conceived. An excellent monograph on this subject has been written by Harlan,* and in it a great variety of procedures are discussed at length.

A few general directions may, however, be useful.

1. The lid is reconstructed in two ways, which may be used separately, or the one employed as an adjunct to the other.

a. By formation of flap and pedicle derived from the skin of adjacent parts. If the ectropion be of the upper lid, it is generally most convenient to borrow the skin from the side of the forehead; but when the lower lid is the one affected, it may be most easily obtained from either the side of the cheek or the inner side of the nose. The disadvantage of this method if used alone is the formation of a fresh and often unsightly scar.

b. By grafts removed from some other part of the body, the inside of the arm or thigh being usually selected, and which have the disadvantage of possessing no pedicle from which nourishment can be drawn. The graft can be taken after the manner known as Thiersch's method, or may include the whole thickness of the skin, in which case the piece to be removed is carefully mapped out with a surface pencil. In dissecting up such a flap care should be taken to remove all traces of subcutaneous fat. In neither method should any sutures be passed *through* the graft itself; but it may be kept in position by passing a suture backwards and forwards across it in a trellis-work fashion. In a few cases where the whole thickness of the lid has been destroyed the cartilage of the ear has been successfully utilised.

2. Before attempting a plastic operation for the formation of a new eyelid, sufficient time should be allowed to elapse after the injury for the skin in the neighbourhood of the eye to have recovered as far as possible its healthy elasticity and softness. All thickening and induration of the cellular tissue should have passed away, and, elsewhere than the scar, the skin should glide readily over the parts beneath it.

3. After having restored the lid by dissection to its proper position, the size of the surface to be covered with the borrowed skin should be accurately noted; and the piece which has to be taken from the temple, or elsewhere, should be of larger dimensions than is apparently required, as the skin contracts about one sixth when detached from the part it originally occupied. It must also be remembered that even if it is a little too large, a further contraction of it will take place during the healing process, which will reduce it to its required size.

4. If the skin of adjacent parts is utilised, great care should be taken to leave a good pedicle through which the vascular supply of the new lid may be maintained until it has become united with the parts beneath it, and a fresh source of nourishment has been established. It is also advisable, in adapting the skin to the lid, to avoid twisting the pedicle on itself more than is absolutely necessary.

5. Before adapting the edges of the new lid to the surrounding skin,

* Norris and Oliver, 'System of Diseases of the Eye,' vol. iii, p. 109.

all bleeding should be arrested. Nothing tends more to delay primary union than a clot of blood between the opposed surfaces.

6. In nearly all cases where a plastic operation is required, it will be well to shorten the tarsal margin of the lid in the manner already described, so as to slightly diminish the size of the palpebral aperture.

7. If the exposed portion of the conjunctiva is much thickened and granular, a portion of it also should be removed with a pair of curved scissors.

8. The chances of success will be considerably increased by temporarily uniting a portion of the corresponding tarsal edges of the upper and lower lids. This is to be accomplished by paring the thinnest possible shaving from the opposed tarsal margins, and then fastening them together with a single fine suture. Immediate union generally follows, and the lids are allowed to remain closed for some weeks or months, until, indeed, all the contraction and cicatrisation consequent on the operation for the ectropion have passed away. When it is desirable to part the lids, the bond of union may be divided on a director with a single stroke of a scalpel.

INJURIES OF THE EYELIDS.

WOUNDS OF THE EYELIDS may be divided into two classes :

1. Those which involve only the skin of the lid.
2. Those which have cut through its tarsal border.

1. **Wounds which involve only the skin of the lid** require the same treatment as similar wounds in any other part of the integument of the body ; but from the delicacy of the skin in this locality, and the importance of avoiding, as far as possible, an unseemly scar, more careful manipulation is needed to bring the edges into accurate apposition.

2. **Wounds which have cut through the Tarsal Border of the Lid.**—In lacerations of the eyelid there are two forms of injury to which its tarsal margin is exposed :

a. The cartilaginous border of the lid may be cut or torn through at any part.

b. The rent may pass through the canaliculus, tearing it away from the punctum lacrymale, which may still remain intact at the extremity of the cartilage.

a. **Where the cartilaginous border of the lid has been cut** the edges of the wound become slightly drawn apart, and an unsightly notch is formed, as shown in Fig. 240.

If the wound has been a clean incised one, the divided ends of the cartilage should be very accurately fitted together and fastened *in situ* by two or more fine silk sutures, which should be passed deeply through the tarsus so as to obtain a



FIG. 240.

firm hold of all the lid structures. A collodion dressing is then applied, and the sutures removed at the end of a week. When, however, the edges of the wound of the cartilage are jagged or irregular, as frequently happens when the lid has been torn by some semi-blunt instrument, it is best first to pare them smooth with a sharp scalpel before bringing them together.

Wounds extending through the whole width of the upper lid may be followed by ptosis from injury to the tendon of the levator palpebræ; or by anæsthesia, more or less complete, over the frontal region from damage inflicted on the supra-orbital nerve.

We have seen a case in which both these accidents occurred from extensive laceration of the lid by a hook.

If no treatment is adopted after a wound of the cartilaginous border of the lid, the edges of the gap are apt to become still more widely separated, and occasionally a certain amount of eversion is also produced. The extent of the deformity will necessarily depend very much on the depth of the wound.

b. When the canaliculus has been torn through and detached from the punctum, as in Fig. 241, a search should be first made for the divided end of the tear-duct.



FIG. 241.

It is, of course, impossible so to adjust the torn parts that the punctum and the canaliculus can again be made to communicate with each other. If, therefore, the open end of the divided canaliculus can be detected, it should be opened up into the lacrymal sac with a canaliculus knife (Fig. 206).

The closed tube will thus be converted into an open canal along which the tears will afterwards flow into their proper channel. The torn parts are then to be brought into their normal position and fastened *in situ* with one or two fine silk sutures.

ECCHYMOSIS OF THE EYELIDS, or, as it is commonly called, “a black eye,” is an effusion of blood into the cellular tissue of the lids, and of the parts surrounding them. It may be limited to one or both eyelids, or it may extend to the cellular tissue of the face around the orbit. The blood is generally absorbed in the course of a week or ten days, during which time the discoloration gradually fades away, but, in doing so, passes through a variety of shades which must be familiar to all. It is very rare that any suppuration follows.

A black eye is occasionally complicated with fracture of one or more of the frontal or ethmoidal cells. This casualty is recognised by an emphysematous state of the eyelids, and of the cellular tissue around the orbit. When the patient blows his nose, air is forced through the fissured bone into the neighbouring cellular tissue. In no case have we ever seen emphysema of the lids productive of any harm, though the

discomfort it occasions is always great. The patient should be cautioned not to blow his nose for some days; the fissured bone will then soon become closed; and if no fresh air is forced into the cellular tissue, that which is already there will rapidly disappear. Pricking the integument with a fine needle to give vent to the air is seldom if ever necessary, and should not be resorted to except in cases of extreme tension of the skin, a condition which is not likely to occur from a simple fracture of a frontal or an ethmoidal cell.

Treatment.—The application of cold immediately after the blow will limit the effusion of blood, and so diminish the extent of the after-discoloration, and may therefore be advantageously used shortly after the receipt of the injury. This is best done by cold evaporating lotions; or by applying ice in an india-rubber bag to the eye; or by a fold of wet linen being laid over the eye, and frequently moistened with iced water. The practice of puncturing the swollen parts, as recommended and frequently adopted by prize-fighters, is essentially wrong. It may, and no doubt does, afford temporary relief to the swelling when it is great, but it renders the part liable to suppuration and erysipelas, neither of which would have been anticipated if the skin had not been cut.

A remedy, which has for many years received considerable credit, is a poultice of the *black bryony root*. It is “made by mixing some of the black bryony root scraped finely with a little crumb of bread. This is placed in a muslin bag over the palpebræ for several hours together; and usually it has an excellent effect in promoting the action of the absorbent vessels.”* The tincture of *Arnica montana* has also acquired a great repute for the power it is supposed to possess of favouring the absorption of blood in cases of ecchymosis. It may be applied pure over the part with a camel’s-hair brush, or it may be used as a lotion.

RESULTS OF INJURIES AND ULCERATIONS OF THE EYELIDS.

ANKYLOBLEPHARON is the union of the margins of the eyelids to each other. They may be either partially or completely united. It is, however, seldom that the adhesion extends throughout the entire length of the lids. The inner third of the two lids is more frequently joined than the outer or middle portion. In nearly all cases of ankyloblepharon, whether partial or complete, a fistulous opening is left at the inner canthus, through which some of the tears find their way on to the face. The union between the lids may be either direct, the two edges being completely adherent, or they may be united by membranous bands passing from the one to the other.

The causes of ankyloblepharon are lacerated wounds, or any accident which produces an abrasion of the corresponding surfaces of the tarsal edges of the eyelids.

Treatment.—When the union between the lids is direct, and a

* Tyrrell, ‘Diseases of the Eye,’ vol. i, p. 200.

fistula exists at the inner canthus, a small director should be passed behind the adherent margins, and out at the fistulous orifice, and upon it the adhesions may be severed with a pair of scissors; or if this cannot be readily accomplished, the lids may be dissected apart with a sharp scalpel.

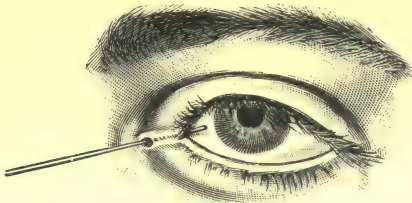


FIG. 242.—A case of partial ankyloblepharon after an injury in which the inner canthus and the inner extremities of both lids were torn by knocking the eye against a whalebone of an umbrella. A fistula exists through which a probe is passed.

If a membranous band is the bond of union between the two lids, it should be divided on a director passed beneath it, and the projecting portions cut off close to the margins of the lids. The chance of success following either of the operations depends very much on the daily dressing of the wound; special care should be taken to keep the lids from

reuniting during the progress of cicatrisation. This may be generally accomplished by daily separating them, and anointing the granulating surfaces with a little sweet oil.

SYMBLEPHARON is an adhesion of the lids to the globe. It is usually produced by an injury which has caused either a destruction or an ulceration of the opposed conjunctival surfaces of the lid and globe, and their subsequent union by granulations. Lime, mortar, and burns from hot metals, or scalds from hot fluids are the most frequent causes of symblepharon, but it may be produced by any agent which either destroys or abrades the corresponding parts of the lids and globe. Most of the very severe cases of symblepharon which have

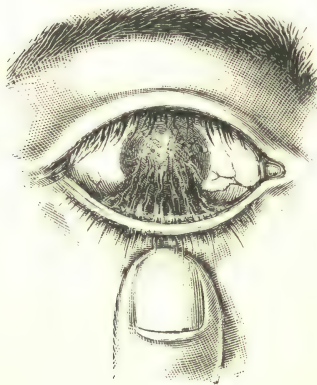


FIG. 243.—A case of symblepharon following an injury from mortar.

come under our notice have been due to lime. If the injury it has inflicted is severe, it is absolutely impossible to prevent the union of the lids to the globe. All endeavours to keep the opposed granulating surfaces apart will fail. The contraction which goes on during the process of cicatrisation draws the lids and globe into close apposition, and direct union will ensue in spite of all efforts to stop it.

Symblepharon is said to be **complete** when the entire inner surface of the lid is adherent to the globe, and **partial** when the adhesion is limited to only a part of the opposed surfaces. Both eyelids may be often seen partially attached to the globe, or the lower lid may be completely united to it; but it is ex-

ceptional to meet with complete symblepharon of both the upper and lower lids of the same eye. The lower eyelid is much more frequently affected by symblepharon than the upper.

Two forms of symblepharon may be recognised :

1. Membranous bands or fræna passing between the lids and the globe.

2. Direct and close adhesions between the opposed surfaces of the eye and lids.

1. Membranous Bands between the Lids and Globe.—This is the simplest and most remediable kind of symblepharon. It is due to a less extensive and more superficial injury than that which produces the second form ; generally to some *limited* ulceration or abrasion of the corresponding parts of the eye and lids. During the healing process the granulations of the opposed surfaces become united, but the constant pull which is exerted upon them by the movements of the globe will often so stretch the adhesions that they will become elongated into membranous bands.

2. Direct and Close Adhesions between the Opposed Surfaces of the Eye and Lids.—These are caused by an absolute destruction of corresponding portions of the conjunctiva of the eye and lids. Deep ulceration or sloughing follows the injury, and opposed granulating surfaces are left, which ultimately become firmly adherent and blended with each other. During the cicatrisation, the contraction of the surrounding conjunctiva draws the lids and globe into such close contact that the movements of the eye cannot stretch the bonds of union, and the lids and globe remain for ever afterwards firmly bound together.

Treatment.—All operations for the cure of symblepharon are as a rule very unsatisfactory ; in the severe cases they generally fail to effect any good, and in the milder ones the relief which is afforded is comparative. It is only in the slight cases that positive good will be found to follow surgical treatment—those in which small membranous bands or tags of adhesion pass between the eyelids and the globe. When these are insulated, so that a probe can be passed beneath them, and the oculo-palpebral fold of conjunctiva still exists entire, much benefit will be derived from an operation.

There are two ways in which these narrow membranous bands may be treated.

a. They may be simply divided by a scalpel or a pair of fine scissors, and by daily passing the end of a probe dipped in a little sweet oil between their cut ends, reunion may generally be prevented. This mode of treatment is, however, only applicable to the very mild cases, where a simple tag of adhesion ties the lid to the globe.

b. If the bands are small, they may be first cut off close to the globe, and the edges of the wound which is thus made in the conjunctiva may be drawn together and united by one or two fine stitches. The other extremities of the bands are then to be severed from their attachment to the lid. As in the first operation, careful daily dressing will be required to prevent a reunion of the cut surfaces, for unless the wound in the conjunctiva closes by immediate union, which it may fail to do, the tendency to a return of the symblepharon is very great.

In those cases of symblepharon where there are **direct and close**

adhesions between the eye and the lids, many different plans of treatment have been tried, but most of them without much success. It is only where the extent of the conjunctival surfaces involved is small, that even amelioration can be hoped for. The lid may be generally easily separated from its union with the globe by a careful dissection, but the great difficulty is to prevent their again uniting. Plates of metal and glass shields have been interposed between the granulating surfaces, but with very indifferent success, for they have generally been extruded during the contraction which accompanies cicatrisation.

Thiersch grafting the raw surface seems to offer the best chance of success. The skin should be taken from some part as devoid as possible of hair, such as the inner side of the thigh or arm. The graft should be cut at least one third bigger than the actual size of the surface which it is to cover, and it should be kept in its place by some such simple method as that described on page 122 in dealing with grafting for pemphigus conjunctivæ, the lids being afterwards united by a few points of suture, and *both* eyes kept bandaged for a few days so as to insure as little movement of the parts as possible.

Pridgin Teale has devised a plastic operation which has met with some success, and which he thus describes :—"The adherent lid having been dissected off the eyeball, so as to leave the globe perfectly free in its movements, one, or if possible two flaps of the conjunctiva are dissected from the sound part of the eyeball, and transplanted into the gap. If any portion of the adherent lid is united to the cornea, the separation of the lid is commenced at the *margin* of the cornea, leaving the apex of the lid still *in situ* as an opaque spot on the cornea."

Taylor's Operation.—"After the separation of the adherent lid from the eyeball, a thin piece of skin is to be dissected from the lid, passed through an incision in the tarsal cartilage, and its raw surface brought into contact with the denuded portion either of the lid or of the eyeball itself. In this way the two raw surfaces of the lid and eyeball are prevented from coming into contact until the wound is healed, and the eyeball itself is set free. The transplanted skin is nourished through its base in the first instance, which is divided as soon as it has taken root in its new situation. It then gradually dwindles, taking the place and assuming the functions of the lost mucous membrane."

There are, however, very many cases of symblepharon where no operation should be attempted. The extent of the adhesions may be so great that it would be worse than useless to endeavour to divide them.

Ankyloblepharon and **Symblepharon** are often associated; indeed, with the union of the margins of the lids it is very general to find also some adhesion between the conjunctival surfaces of the lids and globe. It is, however, rare to find in one eye a complete union of the globe to the lids, and of the lids to each other.

BLEPHAROPHIMOSIS is a narrowing of the palpebral aperture at the external commissure, brought about by the contraction of the scars that form during the healing of the superficial excoriations so fre-

quently seen about the external commissure in cases of long-standing conjunctival disease, especially trachoma.

Treatment.—If the contraction is sufficiently great to cause obvious deformity, it may be remedied by **Canthoplasty**. The external commissure is divided in the horizontal line by straight, blunt-pointed scissors down to the bone. The conjunctiva, slightly undermined if necessary, is then sutured into the wound by three stitches, the first fastening the conjunctiva in the median line to the apex of the wound; and the second and third attaching it to the upper and lower lips respectively. By this means the wound is kept from closing, and the palpebral aperture permanently widened.

For CICATRICIAL EVERSION of the lids, see "Ectropion," page 483.

CHAPTER XXVII.

DISEASES OF THE ORBIT.

ANATOMY.—The orbits form two hollow cones with rounded angles, their exact size varying in individuals, but usually being about two inches in depth. Unlike the optic axes, which are parallel, the orbital axes diverge considerably, owing to the conformation of the outer walls, which slope away from each other, the inner walls remaining almost parallel. The roof and outer wall are strongly arched; the inner wall is also curved, but to a less extent; and the floor, which for its posterior two thirds is chiefly occupied by the sphenoidal and speno-maxillary fissures, slopes downwards and outwards from the apex, so that the latter is on a higher level than the infra-orbital margin, especially at its outer part. The two apices are formed by the optic foramina, through which pass the optic nerves and ophthalmic arteries, and are only about one inch apart, separated from each other by the body of the sphenoid with its contained sphenoidal sinus. The base of the cone is built very strongly, overhanging the eye to an extent that varies in individuals, and, with the projecting nose, forms a ring of defence to protect the globe from external violence.

At the junction of the inner and middle thirds of the supra-orbital margin lies the supra-orbital notch or foramen, through which the supra-orbital vessels and nerves emerge upon the forehead. The ocular nerves and the ophthalmic vein gain access to the orbit through the sphenoidal fissure, which lies just below and external to the optic foramen, whilst the speno-maxillary fissure transmits the infra-maxillary nerve and the infra-orbital artery, which pass thence into the infra-orbital groove, joining the fissure at right angles near its anterior extremity.

The inner wall separating the orbital cavity from the nose with the frontal, ethmoidal, and sphenoidal sinuses, the roof cutting it off from the anterior fossa of the base of the skull, and the floor where it is separated from the antrum, are very thin plates of bone, easily displaced by the pressure of a tumour, or broken through by scissors or knife in a hasty extirpation of the orbital contents.

The orbit is lined by periosteum, which covers the fissures and is

easily stripped from the bone, except at the orbital margin, where it is firmly attached. At the optic foramen, and over the sphenoidal fissure, it comes into direct communication with the dura mater by means of the prolongations of the latter over the optic and ocular nerves as they pass into the orbit.

The contents of the orbit consist of the globe with its vascular, nervous, and muscular appendages, and a cushion of fat, which, loosely held together by a wide-meshed framework of areolar tissue, forms an investing and supporting pad for all the various structures. It is mainly aggregated, however, behind the globe, from which it is separated by Tenon's capsule, and here serves not only as a smooth and soft bed upon which the eye may move, but also as a buffer to guard it from the effects of concussion.

Finally, the continuity of the orbit with the eyelids is effected by a strong fascial band passing to each tarsal plate from the orbital margin, and known as the septum orbitale.

CONGENITAL ABNORMALITIES OF THE ORBIT.

ANOPHTHALMOS.—A rare deformity is the complete absence of one, or as seems to be more often the case, of both eyes. The orbit is found to be unduly small and shallow, and the finger passed within its cavity detects nothing but a smooth fibrous lining. In some of the few instances where it has been possible to make a dissection, an optic nerve, more or less rudimentary, has been apparent, reaching up to the optic foramen; but in others no trace of the nerve has existed, and the optic foramen was absent. The absence of the globe does not affect the formation of the lids, which, though sunken, and presenting a diminished palpebral aperture, are usually well-formed. Anophthalmos is the result of arrested development in the primitive fore-brain from which the usual outgrowth to form the primary optic vesicle, either has not occurred at all,—in which case the optic nerve as well as the globe is absent; or growth has been arrested short of the invagination from which the secondary optic vesicle is developed, under which circumstance the globe is not formed but an optic nerve may be present (*see* "Development," page 92).

MICROPHTHALMOS.—This term is somewhat loosely applied to two varieties of cases:

1. To eyes which, without being actually deformed, are excessively small and flat. Such eyes are always amblyopic, very hypermetropic, and frequently exhibit other congenital anomalies, such as coloboma of the choroid or iris, congenital opacities in the lens, etc.

2. To those cases in which development has been *arrested*, and growth has not progressed beyond a rudimentary stage.

The globe is then represented by a shrunken stump incapable of vision, and, as in anophthalmos, the orbit is often found to be flattened and shallow. Cystic swellings are sometimes formed in connection with these rudimentary eyes (*see* "Microphthalmic Cysts," page 516).

CYCLOPIA, or median fusion of the orbits with a single central eye, is only found in monsters. Various modifications or degrees of fusion both of orbits and eyes may exist.

CONGENITAL VASCULAR TUMOURS AND DERMOID CYST OF THE ORBIT.—*See* "Tumours of the Orbit," page 513.

CRYPTOPHTHALMOS.—*See* "Eyelids," page 452.

PROTRUSION AND RECESSION OF THE GLOBE.

PROTRUSION OF THE GLOBE—EXOPHTHALMOS—PROPTOSIS.—This is a symptom common to almost all the diseases within the orbit. Its extent and direction are determined by the character of the affection, and the part of the orbit from which it originates. When the proptosis is slight it is often difficult to decide whether the protrusion is real or only apparent, as any œdema of the lids or of the conjunctiva of the globe will give a prominent appearance to the eye.

The method of ascertaining and measuring the degree of protrusion is described in the "Examination of the Eye," page 23.

Exophthalmos is caused by—

1. Orbital cellulitis, periostitis, and abscess from any cause.
2. Solid tumours, originating in the orbit, either primarily in the orbital tissues, or secondarily invading the orbital tissues from the globe.
3. Tumours originating external to the orbit, either in the frontal ethmoidal or sphenoidal sinuses, or in the antrum.
4. Vascular disturbances within the orbit, such as pulsating exophthalmos, thrombosis of the cavernous sinus, aneurism by anastomosis, and venous nævus.
5. Cysts of the orbit, usually dermoids, meningocele, or parasitic cysts, of which those produced by hydatids or the *Cysticercus cellulosæ* are the most frequent.
6. The presence of large foreign bodies in the orbit.
7. Hæmorrhage into the orbit after perforating wounds.
8. Emphysema of the orbital cellular tissue after fracture of the inner wall of the orbit.
9. Exophthalmic goitre, and irritation of the cervical sympathetic.
10. Paralysis or division of the ocular muscles, allowing the globe to fall slightly forwards.
11. Extreme degrees of myopia from increase in the antero-posterior length of the globe.

Accompanying the exophthalmos there may be limitation of movement in one or more directions; and if the protrusion is lateral as well as forwards, diplopia is an early symptom. When the exophthalmos is severe the eye may suffer in two ways: firstly, the lids may be unable to meet over the globe (lagophthalmos), and the cornea is then apt to ulcerate; and secondly, undue pressure upon the optic nerve from a tumour may cause atrophy and consequent blindness. With reference

to the latter point it is to be remembered that excessive protrusion of the globe may take place with little or no effect on the sight, provided that such protrusion is not produced by anything that exercises *pressure* on the nerve. This is well seen in Graves' disease, in which the sight usually remains good even in most severe cases.

RECESSION OF THE GLOBE—ENOPHTHALMOS.—This is the opposite condition to Exophthalmos, and indicates an abnormal sinking of the eye into the orbit. It may occur under the following conditions:

1. Microphthalmos.
2. Emaciation. In this case the recession of the globe is due to loss of the orbital fat, and is analogous to the similar falling-in of the cheeks from loss of the buccal pads.
3. Orbital cicatrices. After inflammation of the orbital cellular tissue, cicatricial bands may be formed, which exert traction on the globe.
4. After the removal of an orbital tumour when the globe has been preserved.
5. Slight recession of the globe accompanies paralysis of the cervical sympathetic.
6. A curious condition in which there is normally a state of enophthalmos, but on stooping or compression of the internal jugular vein this is converted into exophthalmos. The phenomenon is most easily explained by the existence of a congeries of dilated or varicose orbital veins, which become engorged, the stasis being favoured by the absence of venous valves. A history of previous traumatism has been obtained in some, but not in all of these cases.
7. Macle hose * and Collins † have placed on record a class of cases in which congenital deficiency of a muscle has been accompanied by enophthalmos, most marked when the opponent muscle has been called into play. Collins regards the phenomenon as probably due to inherent weakness of the check ligaments which normally support the globe, and prevent it from being pulled back during the contraction of the muscles (*see* "Muscles," page 395).

INFLAMMATORY AFFECTIONS OF THE ORBIT.

ACUTE ORBITAL CELLULITIS.—Ætiology and Pathology.—Inflammation of the orbital cellular tissue may be caused by blows on the eye, penetrating wounds of the orbit, or by any violence producing fracture of its bony wall, by the lodgment of a foreign body in the orbital cellular tissue, by the extension of facial erysipelas, by pyæmia, and occasionally by the extension backwards of a suppurative inflammation of the lids no matter how induced. Orbital periostitis, caries, and necrosis of bone may likewise set up or be accompanied by an inflammation of the cellular tissue, which, in common with cellulitis induced by other causes, may lead to the formation of pus.

* 'Trans. Ophth. Soc. U. K.,' vol. xvi, p. 299.

† 'Brit. Med. Journ.,' September 30th, 1899.

The possibility of facial erysipelas extending to the orbit is an important fact to remember. The author has seen two patients, in each of whom the sight of both eyes was destroyed in this way. In three of the eyes thus lost, ulcerative inflammation of the cornea and subsequent adhesion of the globe and cornea to the inner surfaces of the lids had occurred. In the fourth eye the cornea and other media were clear, but there was atrophy of the optic nerve. In this patient large sloughs of cellular tissue had escaped through an ulcerated opening in the upper eyelid, and it is probable that either the nerve was involved in the inflammation, or that its function was destroyed by pressure during cicatrization.

Pyæmic deposits may occur in the orbit due to pyæmia originating in any part of the body, but there seems to be a certain risk of the orbit being secondarily involved in suppurative inflammations of the tonsils or pharynx. We have recently seen two cases of this sort, the orbital inflammation commencing within a short time of the throat affection in each case, and the medium of infection being probably the pterygoid plexus of veins, which form a free channel of communication between the orbital, pharyngeal, and tonsillar veins.

Some cases of orbital cellulitis are characterised by the plastic or fibrinous nature of the exudation; either no pus at all is formed during the attack, or it may be that a small amount of pus appears towards the close of the case, whilst the inflammatory effusion remains chiefly plastic.

The majority of these latter cases appear to be of septic origin, although it may be impossible to trace the origin of the toxæmia. They form, like the cases of a definite pyæmic nature, a class very fatal to life; and even in those in which life is saved it is often only after a long illness and a lost or damaged eye.

Abscess of the orbit may be *acute* or *chronic*. In the former, the inflammatory symptoms, when due to injury, are generally rapid in their onset and progress; but occasionally there is a variable interval of a week or more after the injury, of perfect quiet and freedom from pain before any premonitory symptoms show themselves, though when once started their course is equally acute and rapid.

Symptoms of Acute Cellulitis and Abscess.—Deep-seated pain in the orbit extending around the brow, worse at one time, better at another, but never absent, and steadily increasing in severity. Any pressure on the eye, or even moving it, aggravates the pain. The eyelids become red, shining, and cedematous; and the conjunctiva of the lids and globe, vascular, swollen, and chemosed. The eye is now observed to protrude slightly beyond the level of the other, and this protrusion increases as the disease advances and the pus makes its way to the surface. The displacement is usually not directly forwards, but more or less downwards and outwards, or downwards and inwards, according to the situation of the abscess within the orbit and the part of the eye on which it presses.

With the increasing protrusion of the globe the sight becomes more or less impaired from the pressure which is being exerted on the optic nerve. The orbital fold of skin above the lid becomes obliterated, and

the upper lid so swollen and stretched in front of the bulging eye that it cannot be raised by the patient. Over the most prominent part of the swelling a careful examination with the fingers will detect fluctuation. The most usual spot for the matter to point is rather to the inner side of the space between the supra-orbital ridge of the orbit and the upper border of the globe. Occasionally the suppuration may be more or less confined to one or other side of the orbit, and this will in a great measure determine the site at which the pus will endeavour to make its exit; either the inner, outer, or lower side of the eye may be the part selected. When the abscess is small and limited there may be little or no displacement of the eye.

With all these local symptoms there is always considerable constitutional disturbance. The skin is hot and dry, the patient has occasional rigors, he is restless, and his sleep is broken from pain.

In the plastic form of cellulitis the objective symptoms are especially severe, the temperature ranging from 101° F. to 107° F., and the pain excessive. The proptosis of the globe is as marked as in other forms, and the symptoms all point to the formation of pus, but none is found after free incisions have been made. Unless the case yields to treatment, delirium, coma, and death rapidly supervene, and in four cases of this nature which were under the author's care, and three of which occurred in young subjects, two proved fatal in the course of a few days, in spite of the most energetic treatment.

Prognosis.—Though it is in the plastic and pyæmic forms of orbital cellulitis that most danger to life is to be feared, still, acute orbital cellulitis is always to be regarded as a serious affection. The chief danger lies in the spreading backwards of the inflammation to the meninges of the brain and the onset of a suppurative meningitis, the liability to which increases with every hour's delay in making free incisions when we have indications of the formation of pus, even though its presence is not apparent to the finger. Apart from the danger to life, the eye may be also much damaged, or even destroyed, either by the pressure of inflammatory products or subsequent cicatricial bands causing optic atrophy, or by extension of the inflammation to the globe and the setting up of a destructive panophthalmitis.

Treatment.—As soon as there is an indication of pus make an opening into the orbit. It is not advisable to wait until the presence of pus can be detected by the fingers. The site for incision should be where there is the most distinct swelling and fluctuation, or, if these points cannot be made out, the incision should be made where there is the most distinct evidence of pain on pressure with the finger. The section should pass through the eyelid, and in the case of the lower eyelid the skin should be first drawn a little upwards towards the edge of the orbit, so that the opening may be as low as possible in the face and the risk of subsequent ectropion avoided. The incision must be free, so as to allow of the introduction of a good-sized drainage-tube, and if pus is not found near the surface, the knife should be passed well back towards the apex of the orbit so as to thoroughly open up the cellular tissue. Hot compresses, frequently changed, of lead and carbolic should then be applied, and care should

be taken to keep the wound open and the tube free by daily irrigation with warm boracic or weak carbolic lotion.

It not unfrequently happens after an abscess of the orbit that the wound from the incision only partially closes, and a long sinus remains, from which a slight purulent discharge continues to drain. When this is the case, and when no fragment of necrosed bone can be detected by a probe to account for it, the use of a stimulating injection, such as *zinci sulphat. gr. ij ad aquæ ʒj*, thrown into the sinus with a glass syringe twice a day, will often prove of great benefit. If, however, a portion of dead bone is felt with the probe, time must be given to allow of its becoming detached, or at least partially loosened from the living structure; and then, after enlarging the orifice of the sinus, it may be removed with a pair of sequestrum forceps, first using, if necessary, a gouge, or an elevator, or a pair of fine-cutting bone forceps to separate any portion of bone which may be holding it.

Internally, opium should be administered, in repeated doses if necessary, to relieve pain and produce sleep.

CHRONIC ORBITAL CELLULITIS.—This is most usually the result of chronic periostitis and chronic bone disease, generally of a tubercular or syphilitic nature, or it may arise from an old injury, or the presence of a foreign body within the orbit.

Symptoms.—These are often marked by the very slowness with which they develop themselves, and by the absence of severe pain or the other objective and subjective symptoms that betoken the formation of pus. It frequently happens that the patient does not even seek advice until an increasing protrusion of the eye and a somewhat corresponding diminution in vision excite alarm.

Diagnosis and Treatment.—Chronic abscess of the orbit is often most difficult to diagnose, and may easily be confounded with a sarcoma, or some soft orbital tumour, the elasticity of which closely resembles fluctuation. The exciting cause of the abscess may have been an injury inflicted at some distant period, which has been forgotten, and from which the patient thought he had completely recovered; or the slow progress of the disease, and the comparative and in many cases complete absence of pain during its early stages, may make it difficult, if not impossible for the patient to give a correct account of how or when it commenced. When doubt exists as to the true nature of the case, an exploratory incision should be made into the tumour, and the surgeon should be prepared to act at once on the information it will afford him. If it is an abscess, the incision should be enlarged sufficiently to give a free exit to the pus; but if, on the other hand, it should prove to be an orbital tumour, it should, if practicable, be removed without any further delay.

SEPTIC THROMBOSIS OF THE CAVERNOUS SINUS is a rare and very fatal complication of acute orbital cellulitis, the thrombosis commencing, in the first instance, in the orbital veins, and extending thence into the cranial cavity. It is also said to have occasionally arisen in the course of a suppurative otitis media, but in such cases

one would suspect that it was secondary to a thrombus commencing in the lateral sinus.

Cavernous sinus thrombosis may be suspected when, in addition to the symptoms of acute cellulitis, the fever increases with pyæmic ranges of temperature and rigors, and cerebral symptoms make their appearance, notably headache, vomiting, and paralysis of ocular and other nerves. Locally the proptosis, due, in the first instance, to inflammatory swelling, will become more marked, the vision will be affected, the lids will become more swollen and oedematous, and the superficial veins enlarged, tortuous, and pulsating. If the patient is first seen when in this condition the case may resemble one of pulsating exophthalmos; but the grave condition of the patient, the signs of phlegmonous infiltration, the history, and the absence of the characteristic symptoms of an arterio-venous communication, especially of the rough thrill and whizzing bruit, will clear up the diagnosis.

The **prognosis** is bad. The infective thrombus is likely to extend into other sinuses, and then meningitis or cerebral abscess will cause a speedily fatal termination.

Treatment.—The only course likely to prove of benefit is to cut off the supply of infective material by free incisions into the orbit, followed by the maintenance of efficient drainage and frequent irrigations, though but little can be hoped from this if cerebral symptoms have already made their appearance.

For thrombosis of the cavernous sinus, the result of injury, *see* “Pulsating Exophthalmos,” page 510.

INFLAMMATION OF TENON’S CAPSULE—TENONITIS.—Several cases ascribed to a primary inflammation of Tenon’s capsule—that is, arising independently of and without any inflammation of the orbital cellular tissue—have been reported. The symptoms appear in the main to resemble a slight attack of orbital cellulitis, the distinguishing features being the great pain that accompanies any attempt to move the eye, owing to the stretching of the inflamed fascial sheaths, and the limitation of the swelling to the upper lid, the exact reason of which is not apparent. The affection has been noted in an idiopathic form when gout or rheumatism seems to be the chief factor in its origin, and it has also followed operations upon the ocular muscles, in which case the inflammation is likely to pass into a general cellulitis.

Treatment.—This is similar to that already given for orbital cellulitis. Salicylates and gouty remedies should be prescribed if the history favours a rheumatic or gouty origin.

PERIOSTITIS OF THE ORBIT.—Orbital periostitis is usually of a **chronic** nature, but small portions of the periosteum are occasionally **acutely** inflamed. Acute diffuse periostitis rarely, if ever, affects the orbit.

Acute periostitis of the orbit is an acute inflammation of a portion of the orbital periosteum, which may have been detached from the bone or otherwise injured by some penetrating wound of the orbit, or

may have become secondarily affected during an attack of orbital cellulitis. It is accompanied by severe pain and by the formation of pus, which will give rise to all the symptoms described under "*Acute Orbital Cellulitis*." The piece of bone which is subjacent to the inflamed periosteum usually perishes, and a discharge of foetid pus continues to drain through the external wound by which the matter was first evacuated, until the dead bone is detached from the living and removed from the orbit.

Treatment.—When it is traumatic, or is due to orbital cellulitis, the application of warm fomentations gives the most relief during the acute suppurative period. As soon as there is reasonable evidence that pus has formed, an incision should be made into the orbit to give exit to it. For the chronic discharge kept up by the presence of diseased bone, see "*Treatment of Chronic Periostitis of Orbit*." The patient should be ordered tonics, stimulants, and a liberal diet. The disease is very depressing, and it is not specific; iodide of potassium and mercurials are therefore contra-indicated.

Chronic periostitis of the orbit is nearly always syphilitic. It usually leads to the formation of nodes or the effusion of lymph beneath the periosteum. The most frequent position of the nodes for which the ophthalmic surgeon is consulted is on the frontal bone, just over the brow, but they sometimes occur within the orbit and give rise to grave symptoms. The nodes of the flat bones usually differ in their progress from those which are so commonly seen on the tibia and other long bones; for whereas in the latter they frequently ossify and form bony projections, in the former (the flat bones), and especially in those of the skull, the effused lymph often softens, and pus is formed beneath the periosteum, and a portion of the subjacent bone either exfoliates or becomes carious.

Symptoms.—Dull aching pain, which is worse at nights, when it is usually sufficiently severe to prevent sleep. Swelling of the part is evident to the sight and touch when it occurs over the superciliary ridge; but when the periostitis is within the orbit the swelling is indicated by the impaired motions of the eyeball, or by paralysis of one or more of its muscles; and if the swelling is large there is some protrusion or displacement of the eye. If the node within the orbit should soften and pus be formed, all the symptoms which characterise orbital abscess will gradually develop themselves, and after the matter has been evacuated, a chronic discharge will probably continue until some portion of the orbital bones has exfoliated.

Treatment.—In chronic orbital periostitis there is generally a past history of syphilis, possibly dated back many years, but when this cannot be obtained the surgeon must use his own judgment as to the patient's veracity, and treat the case accordingly. The most useful medicine is the iodide of potassium, which should be given in the first instance in doses of from gr. iij to gr. v three times a day, but if these fail to do good they may be increased up to gr. viij or gr. x. To relieve pain and favour the absorption of the effused lymph, the Unguent. Hydrarg. cum Belladonnâ (F. 63) may be rubbed into the

brow, and left on during the day. When the pain is very severe, a subcutaneous injection of gr. $\frac{1}{6}$ to gr. $\frac{1}{3}$ of the acetate of morphia, or gr. v of the pil. saponis cum opio (B. Ph.), may be given at night. If these remedies fail, a mixture of iodide of potassium and perchloride of mercury may be ordered. If the node within the orbit soften, and pus be formed, an opening should be made to give vent to it; and if a chronic discharge continue, and this be found dependent on a portion of dead bone not yet exfoliated, the sinus should be syringed out twice a day with a solution of hydrarg. perchlor. (1 in 4000), or with a very weak solution of carbolic acid, about miv ad aquæ ʒj , or some mild astringent lotion. As soon as the probe detects that the bone is loosened, the sinus should be enlarged and the exfoliated piece be removed with a pair of forceps.

NECROSIS AND CARIES OF THE ORBIT.—Necrosis of a portion of one or more of the orbital bones generally arises from periostitis induced by an injury, or by an acute orbital abscess; whereas caries is usually produced by some constitutional taint, such as syphilis or struma. In the two preceding sections it is shown that both caries and necrosis may follow inflammation of the periosteum of the orbit. Caries of the malar bone is, however, more frequent than caries of the orbit, and it is a form of the disease which the ophthalmic surgeon is frequently called upon to treat, as it is the cause of a very troublesome ectropion.

Treatment.—For necrosis no permanent cure can be effected until the piece of dead bone has been removed. Time should be given to allow of its being loosened from the living structures, and then, guided by a probe passed through the sinus by which the discharge escapes, an incision should be made down to the necrosed bone, which should be removed with a pair of fine sequestrum forceps.

For caries the treatment is different. True caries is strictly ulceration of bone, or, in other words, a degeneration of the bone particles, which are thrown off and may often be detected in the discharge. As in ulcers of the skin, the object of the treatment is to restore healthy action, and thus produce cicatrisation. This may be aimed at by constitutional and local treatment. Where there is a syphilitic taint the iodide of potassium with iron, or the iodide and bromide of potassium combined, or other antisiphilitic remedies may be given; but when the disease may be attributed to a strumous diathesis, cod-liver oil, the syrup of the iodide of iron, or the hypophosphites will generally do good, and especially if at the same time the patient can obtain sea air and a nutritious diet, of which milk and eggs form a part.

Very good local applications are the lotio rubra (B. Ph.), a lotion of carbolic acid, 1 in 100, or of chloride of zinc gr. j ad aquæ ʒj . They should be injected up the sinus with a glass syringe twice a day, and if one lotion causes too much irritation another should be substituted. If, however, all these remedies fail, a cure may be often accomplished by making an incision down to the carious bone and gouging away the soft and diseased structure, after which the sinus is scraped and lightly packed.

INJURIES OF THE ORBIT.

FRACTURE OF THE ORBIT.—A fracture of the orbital walls may be the result of indirect or direct violence. From indirect violence it may occur from falls or blows whereby the anterior fossa of the base of the skull is fractured, whilst direct fracture may be caused by gunshot and other varieties of penetrating wounds, or by crushing blows on the face or side of the head.

Fracture of the orbit is often associated with fracture of other portions of the skull, and in such cases it frequently happens that the contusion or laceration of the brain produced by the blow is sufficient to cause death, independently of the injury which the cranial bones have sustained.

The signs of orbital fracture are often equivocal, and the injury only recognised by a chain of collateral evidence. In others no positive diagnosis can be made at the time, though the extent of the damage may be revealed in the progress of the case.

The several signs, not necessarily diagnostic of themselves, but which, taken in conjunction with the history, will point to orbital fracture, are as follows :

1. Fracture of the inner wall of the orbit opening up the frontal or ethmoidal cells is often accompanied by emphysema of the cellular tissue of the lids and surrounding parts. (*See also* page 490.)

2. Hæmorrhage into the orbit suddenly occurring upon a severe blow or fall is very suggestive of fracture. The globe may be considerably proptosed by the effusion of blood behind it, the cause of the proptosis being evinced by the extravasation of blood under the conjunctiva and the engorgement of the lids. Severe orbital hæmorrhage may, however, be the result of a penetrating wound without fracture.

3. Sudden complete blindness following a blow on the head or a fall indicates compression, wounding, or division of the optic nerve by a displaced fragment of bone. Similarly, optic atrophy in one eye supervening some weeks or months after such an injury points to a fracture in which the nerve has been involved by the repairing callus. In the case of penetrating wounds it is obvious that injury to the nerve may be caused by the weapon or missile.

4. Paralysis of the infra-orbital nerve after a blow crushing the superior maxilla, especially when accompanied by intra-orbital hæmorrhage indicating the wounding of the infra-orbital artery, points to the extension of the fracture into the floor of the orbit.

5. The onset of meningitis or symptoms of cerebral irritation within a few days of a penetrating wound of the orbit renders it certain that the orbital walls have been perforated.

There is one form of fracture which is confined to the walls of the orbit, and which is very fatal. It is caused by direct violence, and is commonly produced by a forcible thrust in the eye with a sharp or semi-blunt pointed instrument, such as the points of a pair of scissors, the end of an umbrella, or a foil, or by the stem of a long tobacco pipe.

The orbit is penetrated, and the end of the stick, or whatever it may be, is thrust against its roof or the upper part of its inner wall, which it in some cases fractures, whilst in others it breaks its way through the bone and penetrates the substance of the brain. From such an injury the patient seldom recovers; even when the bones are broken, but not penetrated, the sharp splinters usually create such irritation of the brain and its membranes that a fatal result ensues.

One peculiarity of this accident is that its severe nature is apt to be often overlooked; the external wound may be small, the immediate symptoms may be trifling, and the patient, if a mechanic, may be able to continue his work for some hours, or it may be for two or three days, before his condition obliges him to desist. Symptoms of inflammation and suppuration may then come on, coupled with those of cerebral or meningeal irritation; the patient may pass rapidly from slight delirium to complete coma, and die in a period varying from a few days to two or three weeks.

Treatment of Fractures of the Orbit.—Fracture of the orbit requires the same treatment as fracture of any other portion of the bones of the skull, with the exception that even if there is reason to believe that a fragment of one of the orbital bones may be pressing injuriously on the brain, no operation can be attempted to dislodge it. Absolute rest, both mental and bodily, should be enjoined in all cases where a fracture of the orbit is suspected. The patient should be kept in bed, an aseptic dressing—surmounted, if thought fit, by an india-rubber bag of ice—should be laid over the eye and brow of the injured side, and the bowels should be freely acted on by a brisk purgative. All stimulants should be forbidden, and a limited diet should be ordered.

If there is much pain in the head six or eight leeches should be applied to the temple, and these may be repeated in twenty-four hours if the symptoms become more urgent.

Blood effused into the orbital tissues will probably become gradually absorbed, and it is inadvisable to make any incisions to remove clots unless the proptosis is very severe. Even when every care to preserve asepsis is taken, such a proceeding may easily be followed by decomposition of the blood-clot and a resultant orbital cellulitis. Empysema of the lids requires no treatment and will soon disappear as the fracture heals, but the patient must be warned against blowing his nose for some time.

Empysema of the Orbit.—*See* “Fracture.”

Hæmorrhage into the Orbit.—*See* “Fracture.”

FOREIGN BODIES IN THE ORBIT.—The lodgment of a foreign body within the orbit is one of the most dangerous accidents which can be met with in ophthalmic practice, as it not only always involves a serious risk to the eye, but it places even the life of the patient in considerable jeopardy, and in some instances has caused death. It may prove hurtful to the patient both by the immediate and secondary effects it is liable to produce.

The immediate effects which may arise from the lodgment of a foreign body in the orbit are—

1. In its passage into the orbit it may either injure the parts within the eye, or rupture its external coats.

2. Although the eye itself may escape injury, the optic nerve may be wounded, and absolute blindness follow.

3. It may injure the walls of the orbit either by penetrating them or by causing fracture.

The secondary effects which a foreign body within the orbit may excite are—

a. If a foreign body has escaped observation, and has been allowed to remain buried in the orbit, it may excite orbital cellulitis and abscess. This may lead on to a general inflammation of the globe, which may



FIG. 244.—This represents a piece of stick removed from the orbit of a child three years of age. Seven weeks previously, whilst riding in a perambulator, the child fell with his face on to the point of a stick with which he was playing. There was complete ptosis of the left eye, the globe was protruded a quarter of an inch and fixed in the centre of the orbit from palsy of all the ocular muscles, the pupil was widely dilated, and, as far as could be made out, the eye was blind. At the inner and lower part of the orbit was a small fistulous opening, from which there was a thin discharge. An incision was made into the lower part of the orbit, and a piece of stick exactly corresponding to the woodcut was removed. The child rapidly recovered, and the movements of the eye were almost restored, but the sight was lost.

end in great impairment of vision, or in complete destruction of the eye from suppuration.

b. As a consequence of the orbital inflammation, a portion of the bones of the orbit may become necrosed.

c. The inflammation may extend backwards along the periosteum lining the orbital walls to the membranes of the brain, and prove fatal by meningitis, tetanic convulsions, or abscess of the brain.

In spite of these manifold dangers it is, however, remarkable how often a foreign body has been lodged in the orbit or adjacent cavities without the patient having suffered any great inconvenience from its presence.

Some years ago the author extracted from a patient aged 28 the breech of a muzzle-loading gun, which had been impacted for twelve years in the right frontal sinus and upper part of the nose. The following is the history of the case :

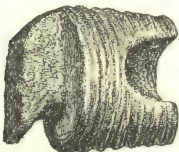


FIG. 245.

The man stated that twelve years previously his gun burst whilst shooting wild fowl, and produced a severe wound between the eyes and many smaller ones on his face. He was laid up for four months, during which time both eyes became inflamed and the sight of the left was nearly destroyed. He was attended through his illness by several medical men, but they never found, nor did they appear to suspect, the presence of a foreign body. He first detected something loose in the nostril about two years and a half before he came under our care. When admitted into the Middlesex Hospital a deep scar was seen between the frontal sinuses, and the upper part of the right side of the nose was swollen. There was an offensive discharge from the right nostril, and the right eye was

more prominent than the left. On examination with the finger in the nostril, a hard and movable body was felt to be lodged beneath the scar and in the upper part of the right nasal cavity, and from the metallic touch it gave to the probe we concluded it to be a portion of the gun-barrel. Attempts were first made to remove this hard mass with a pair of strong forceps introduced through the nostril, but failing to accomplish this, the right cavity of the nares was laid open by an incision carried through the nostril along the fold which forms the line of demarcation between the cartilage of the nose and face. The piece of iron was then seized with the forceps, and, after considerable traction, removed; it weighed an ounce and a quarter, and was covered with a thin layer of rust. The wound was united with two fine sutures. The patient recovered without a bad symptom, and in a week left the hospital.

The woodcut (Fig. 245) represents the actual size and shape of the screw breech of the gun.

Treatment.—Whenever it can be clearly established that there is a foreign body within the orbit, which nowadays can in the vast majority of cases be demonstrated, and if present, localised with mathematical accuracy by means of the X rays and Mackenzie Davidson's apparatus (see page 297), the treatment is, as a rule, to endeavour to remove it as soon as possible. Very frequently the magnet, especially Haab's powerful instrument (Fig. 144), will effect the extraction of a piece of metal with but little additional aid from the surgeon's knife, and this method should always be tried first when any chance offers for its success.

There will remain, however, a few cases when a wise discretion will stop the surgeon from undertaking any operation; and in this class will be placed such small bodies as shot, not amenable to treatment by the magnet, and which the X rays have located deeply embedded in the cellular tissue. It should be remembered that a small mass of metal may be thus impacted for years without creating any disturbance, and entailing less risk from its presence than that involved by an operation—perhaps attended by failure—which extensively opens up the orbital cellular tissue.

Method of extracting a Foreign Body from the Orbit.—In cases of a recent wound where the foreign body is susceptible to the magnet, Haab's instrument should be applied to the wound, and the same principles followed in applying it, as have been already laid down in discussing the removal of foreign bodies from the globe by this method (see page 302).

When the magnet cannot be obtained, is not suitable, or fails to act in this way, an operation to remove the foreign body may be undertaken in the following manner:

The outer canthus should be freely divided, either by a pair of scissors or with a scalpel, to allow of the upper lid being completely turned up, or the lower one drawn down, according to the locality in which the foreign body is lodged. If it has entered the orbit *above* the globe the upper lid is to be raised, and the reflection of conjunctiva between the lid and the eye is to be divided over the spot where the foreign body is suspected to be lying. A probe or the little finger may then be passed through the wound into the orbit by the side of the eye, and having felt the object it may be seized and drawn out with a pair of sequester forceps. When the foreign body has entered the orbit *below* the globe, the lower lid must be drawn down and the lower oculo-palpebral fold of conjunctiva must be divided, but the remaining steps of the operation are the same as those already described.

If the foreign body has become entangled with one of the recti muscles, or from any other cause one of them should interfere with its easy withdrawal from the orbit, it is better at once to divide the muscle with a pair of scissors as close as possible to the globe, rather than use any force to overcome the resistance it may be causing.

PENETRATING WOUNDS OF THE ORBIT are always serious. The exact injury which has been inflicted can often be only surmised, and time is required for the manifestation of symptoms before either a correct diagnosis or prognosis of the case can be formed. The instrument which has caused the accident should be examined to see if any fragment of it has been broken off and left behind in the orbital cellular tissue, and the direction in which it penetrated the orbit should be noted. The patient should be kept under careful supervision for some days, so as to enable the surgeon to treat from the onset any unfavourable symptoms that may arise. Even when no injury has been inflicted to the bones of the orbit, orbital cellulitis and abscess are very apt to ensue.

PULSATING EXOPHTHALMOS.

A disease characterised by protrusion of the eyeball and symptoms *apparently* referable to an aneurism within the orbit.

Two varieties which produce the same symptoms are to be distinguished—(1) *Spontaneous or Idiopathic*.

(2) *Traumatic*.

Ætiology.—Under its old name of "*intra-orbital aneurism*," this disease was long a puzzle to pathologists. Much light was first thrown upon the subject in a valuable paper by the late Mr. W. Rivington.*

The two chief conditions which may give rise to the disease are—

1. Thrombosis of the cavernous sinus and orbital veins.
2. An aneurismal varix in the cavernous sinus, the result either of (a) the rupture of a pre-existing aneurism of the internal carotid into the blood sinus; or of (b) the rupture of the internal carotid into the venous sinus from traumatism.

The two conditions have been usually found associated. When the first condition alone is present the typical symptoms of arterio-venous communication will be absent (*vide* Symptoms).

In addition, one or two cases have been described in which conditions other than those mentioned have been found.

a. Simple aneurismal dilatation of the internal carotid in the cavernous sinus.

b. Aneurism of the ophthalmic artery, either at its point of origin or within the orbit.

It is difficult to see how (a) could produce the symptoms of this disease, whilst (b) is of excessively rare occurrence.

In the *spontaneous cases* the disease is due in the vast majority of instances to the rupture of a pre-existing aneurism of the internal carotid

* 'Med.-Chir. Trans.,' vol. lviii, 1875.

into the cavernous sinus. The patients are usually elderly and the subjects of general arterial degeneration. The *traumatic* cases are the result of severe injury to the head, either from a fall or some crushing blow. Many cases have exhibited characteristic symptoms of fracture of the base of the skull.

Symptoms.—In spontaneous cases the onset is often very sudden and without previous warning. It has frequently been described by patients as a sudden sense of something snapping in the head, after which the symptoms rapidly make their appearance. In traumatic cases the onset is very variable; symptoms may appear within a few hours of the injury, or may not infrequently be delayed for weeks or months. The severity of the head symptoms may mask the condition for some time, or the artery may be only damaged at the time of injury, and rupture at a later date from subsequent inflammation of its walls.

The symptoms themselves are similar in both spontaneous and traumatic cases. There is well-marked proptosis or protrusion of the globe, which will pulsate visibly or upon slight pressure with the finger. A soft, elastic, ill-defined swelling with expansile pulsation due to a congeries of enlarged pulsating veins will be generally noticed towards the inner side of the upper lid projecting from under the orbital arch, whilst upwards over the forehead and outwards towards the temple swollen tortuous pulsating veins may be also noticed. The pulsations of both globe and veins are, if the disease be due to arterio-venous communication, synchronous with the carotid pulse. A rough thrill will be often felt towards the inner side of the orbit, and with the stethoscope a loud whizzing bruit can be heard, which is conducted along the enlarged veins. Pressure upon the carotid at once arrests all pulsation, bruit, and thrill, and may cause some diminution in the proptosis. The lids are swollen and oedematous, as is also the conjunctiva, which is coursed by enlarged tortuous vessels, and the affected side of the face is also frequently noticed to be more flushed than the other side.

The movements of the globe are usually more or less limited, and very frequently there is a squint due to paralysis of one or more of the ocular nerves. The sixth nerve is the one most commonly affected, on account of its position in the cavernous sinus between the artery and venous channel; but the other ocular nerves may be involved, and in a few cases total ophthalmoplegia externa and interna has been noted. The vision is generally affected to a serious extent. Sometimes definite optic neuritis is present, whilst in any case the retinal veins will be seen to be enormously swollen and tortuous, and often pulsate visibly. Retinal hæmorrhages are not infrequent. As a rule, pain is severe and sometimes agonising, and it is accompanied by constant noises in the head, which have been compared to the beating of a sledge-hammer, or to the whizzing of a threshing machine, or to the blowing of a pair of bellows.

Diagnosis.—All these symptoms, with the exception of thrill, whizzing bruit, and noises in the head, might be produced by thrombosis of the cavernous sinus alone; but these three symptoms indicate arterial mischief for a certainty. Further, the pulsations when due

simply to venous thrombosis would *not* be synchronous with the carotid pulse. The only other disease that is at all likely to be confused is a pulsating sarcoma of the orbit, and in this case the rapid growth, absence of history of injury, with the absence of thrill, whizzing bruit, and noises in the head, and possibly the presence of cachexia or metastatic growths, are the signs upon which reliance must be placed.

Prognosis.—As regards life, cases have remained stationary for years without any active treatment being employed. The complications to be feared are rupture of an aneurismal sac into the cranial cavity and profuse epistaxis, both of which have in rare cases proved fatal. On the other hand, statistics show that the disease is very amenable to treatment by ligature of the common carotid artery, and that the vision has in many cases quite recovered after this operation, though other cases have gradually drifted into total blindness in spite of treatment.

Treatment.—Complete rest in bed for a prolonged period should be first tried with local applications, ice, etc., to the head, aided by constitutional measures consisting of Pot. Iod. and a low dry diet, as recommended by Tufnell for aneurism. These measures have in some instances proved sufficient. If unavailing, recourse should be had either to (a) *Digital compression of the common carotid artery*, or to (b) *Ligature of the common or internal carotid artery*.

Digital compression has been successful in a few cases, but it requires a large staff of assistants, and is sometimes excessively painful to the patient.

Ligature of the common carotid has been by far the most successful measure adopted. A large number of cures have been reported, but the value of the statistics is frequently discounted by the shortness of the time that has elapsed between the operation and the report. Two or three deaths have followed the operation, and some failures, but the vast majority have been much relieved, and some permanently cured, although ligature of the common carotid on the other side has, in a few cases, been necessary before a successful result was obtained. Ligature of the internal carotid has scarcely ever been tried, but it seems to present certain advantages over ligature of the common carotid artery, notably in the fact that all reflux of blood through the internal carotid trunk from the free anastomoses of the external carotids across the neck is thereby prevented. Arterial ligature may be also supplemented by ligaturing the large pulsating veins on the forehead or temple.

All forms of intra-venous injections are to be most strongly condemned. It need scarcely be added that if the symptoms of any case were purely the result of a block in a venous sinus, treatment by ligature of the carotid would not be followed by any material benefit.

TUMOURS OF THE ORBITAL CELLULAR TISSUE AND PERIOSTEUM.

These may be divided into three classes:

1. **Those which originate within the orbit.**
2. **Those which commence within the eye and afterwards extend to the orbit, or reappear in the orbit after the eye has been excised.**
3. **Those which have their origin at some site beyond the eye or orbit, but have extended into the orbital cavity.**

Class 1.—Tumours which Originate within the Orbit.—These soon manifest their presence by the pressure they exert on the eye. All sight may be destroyed by mechanical pressure of the tumour on the optic nerve, or by secondary extension of the growth to the nerve and its sheath; or, if the exophthalmos is great, the lids may fail to cover the globe, and the cornea may ulcerate and slough from exposure. As the growth advances the globe is protruded in one or other direction, according to the position the tumour occupies in the orbit. It is, however, often astonishing to what an extent the eye may be projected, and the optic nerve consequently stretched, without producing any great impairment of vision; and also how the lost sight will be regained after the eye has been restored to its proper position within the orbit by the removal of the morbid growth.

The tumours which originate within the orbit may be benign or malignant, and may be extirpated with more favourable prospects of success than those which first show themselves within the eye.

The **benign** tumours embrace (a) *congenital vascular tumours*, (b) *cysts of the orbit*, and (c) *periosteal tumours*.

The **malignant** tumours consist of various forms of sarcoma arising either in the cellular tissue or periosteum.

a. Congenital Vascular Tumours.

CIRSOID ANEURISM, OR ANEURISM BY ANASTOMOSIS, is an exceedingly rare congenital condition. It consists of a morbidly developed network of pulsating arterioles in the subcutaneous cellular tissue, forming a prominence beneath the skin, which increases in size, and is rendered turgid by laughing or crying. To the touch it has a tough, doughy feeling, quite distinct from fluctuation.

Treatment.—When the vascular growth is of limited extent, and is only a short distance within the orbit, it may be surrounded subcutaneously with a ligature and tied. The same proceeding may be adopted to a portion of a growth of a larger size which extends beyond the orbit. There are, however, cases to which this plan of treatment is inapplicable, as when the growth is of great dimensions, bulges the eye, and is rapidly increasing. For such tumours the effect of temporary pressure with the finger on the carotid should be tried, and if this fails in arresting the pulsations and in reducing the fulness of the growth, the carotid artery should be ligatured.

Haynes Walton succeeded in curing a large cirroid aneurism of the orbit in a child four months and three weeks old, by tying the carotid artery. After the operation the protrusion of the eyeball was sensibly diminished, and the child recovered without a bad symptom.*

The injection of coagulating fluids into the orbit is fraught with danger to life, and is strongly to be condemned.

The condition known as "*Pulsating Exophthalmos*" is not strictly an orbital tumour, and is discussed elsewhere (see page 510).

VENOUS NÆVUS OF THE ORBIT.—This is another variety of congenital orbital tumour. It may be simply a superficial extension into the orbit of a nævus of the lid, or it may be a much more serious tumour placed deeply in the orbital tissues, causing proptosis of the globe, and sometimes extending forwards into the cellular tissue of one or both eyelids. The former variety has already been discussed under "*Nævus of the Lid*." The latter class which is considered here is much rarer, and the vessels usually of large size, the tumour being a true cavernous angioma consisting of an agglomeration of dilated veins held together by a framework of tough connective tissue.

The **diagnosis** is often obscure and difficult. There is protrusion of the eye, which varies in degree, being greater at one time than another, and increased by any strong emotion, such as crying or laughing. An examination with the finger round the orbit may fail to detect any tumour immediately within the orbital edge, the vascular growth being placed directly behind the eye and at the bottom of the orbit. If, however, the nœvoid tumour has advanced sufficiently forward to be detected by the finger, it will be felt as a soft, cushiony, elastic mass, which *will yield no pulsations*, whilst if the tumour has extended into the lids the latter will present a typical doughy and purplish swelling which will cause a partial closure or drooping of the lids over the eye.

Treatment.—There are two methods of dealing with a venous nævus of the orbit when, either from its size or rapid increase, active treatment is rendered necessary:

1. The superficial portion of the growth which affects the lids may, when practicable, be ligatured subcutaneously, or inflammatory action sufficient to induce coagulation of the blood within the vessels may be excited by electrolysis or by pricking the tumour at many points with a needle-pointed cautery. The deeper part of the growth may be treated by applying the cautery at two or three points through the integument close to the margin of the orbit, and thrusting it well into the orbital tissue, as in a case reported by Spencer Watson which he cured in this way.†

2. The nœvoid tumour within the orbit may be excised. This operation, however, should not be attempted unless the growth is producing great proptosis of the globe, sufficient to render active interference absolutely necessary, and to justify the sacrifice of the eye, as

* 'Diseases of the Eye,' 2nd edit., p. 230.

† 'Trans. Clin. Soc.,' vol. vi, p. 166.

before the venous tumour can be reached the globe must be enucleated. After the removal of the eye the nævoid tissue should be drawn forwards with a pair of toothed forceps, and then rapidly cut away with a pair of blunt-pointed scissors curved on the flat. When the greater part of the vascular tissue has been excised the bleeding will have probably diminished, and all further hæmorrhage may be arrested by plugging the orbit with small pieces of sponge soaked in the liquor ferri persulphatis, and afterwards applying a firm pad of lint with a bandage over the closed lids.

The injection of the vascular growth with astringent solutions is accompanied with great danger to life, as already stated in the preceding section, and should not be attempted.

b. Cysts of the Orbit.

MENINGOCELE is due to arrest of development of the orbital roof at its upper and inner angle. It forms a tense fluctuating swelling with an expansile pulsation synchronous with the carotid beat. When the bony defect is fairly large it may be partially reduced by pressure, upon which, symptoms of cerebral compression may appear, and relaxation of pressure is speedily followed by return of the swelling to its former size. It may also be noticed that the growth increases in size or becomes more tense when the child cries. It is most usual for a meningocele to extend beyond the confines of the orbit towards the middle line, and in rare cases the whole of the nasal process of the frontal bone is absent, so that the tumour forms a median swelling over the root of the nose. The investing skin may be normal, but is often thin in texture, so that the swelling is semi-lucent and the skin appears of a bluish hue. Examination will generally reveal the bony deficiency in its base, though in some cases this point may be difficult to make out.

A meningocele is most likely to be mistaken for a dermoid, but the differential diagnosis only presents some difficulty, firstly, when the characteristic features of a meningocele are masked by the partial or complete closure of the bony deficiency; or secondly, when, as is rarely the case, the dermoid is connected with the dura mater and transmits cerebral pulsations (*see also* page 516). In the former case, the mobility of the dermoid as contrasted with the fixed character of the meningocele, its history of perhaps steady growth after a long stationary period, its more circumscribed outline, and the fact that it does not trespass on the middle line, will guide us to a correct diagnosis. In the second case, in addition to the above points, the pulsations of the dermoid will probably be much more feeble than those commonly present in a meningocele, the tumour will be quite irreducible, and it will not vary in size nor become tense when the child cries. Under very exceptional circumstances, a cyst arising in connection with a microphthalmic eye may simulate a meningocele. The matter is again referred to in the next section.

Treatment.—It is dangerous to interfere with a meningocele unless the opening in the bone is closed or very small, and it is therefore, as a general rule, best left alone. If it becomes necessary to deal with it on account of a rapid increase in size or a threatening rupture, the best

method is to transfix and ligature the base of the swelling, taking the utmost precautions to preserve asepsis.

MICROPHTHALMIC OR SEROUS CYSTS.—In cases of rudimentary microphthalmic eyes, a cystic formation is occasionally seen which forms a fluctuating swelling, usually occupying the floor of the orbit and protruding beneath the lower eyelid.

The pathology of these cystic swellings has been well worked out by Kundrat, Rindfleisch, Czermak, Collins, and others. The cyst is always in direct communication with a rudimentary eye, although the latter may not be obvious to clinical examination. Its interior is lined with retinal tissue and its cavity is filled with a limpid straw-coloured fluid. It probably owes its origin in some way to arrest of closure of the foetal cleft, and Collins* suggests that it may be caused by continued growth of the retina after arrest in growth of the mesoblastic elements, so that the retina bulges through the unclosed foetal cleft.

In rare cases the cyst protrudes the upper instead of the lower eyelid, and occasionally it attains a large size, so that the orbital cavity is in great measure filled by it. In such a case, and especially if at the same time there is some deficiency in the bony orbit, it is possible for an impulse to be conveyed to it from the adjacent meninges, as in a case reported by Snell,† in which the cyst pulsated synchronously with the anterior fontanelle, and also became tense when the child cried. Thus a cyst of this nature may very closely simulate a meningocele, but the site of swelling and the presence of a microphthalmic eye or apparent anophthalmos would help to clear up the diagnosis, whilst examination of the fluid would also be of service.

Treatment.—A small cyst, if not producing any obvious deformity, is best left alone. Evacuation of the contents and pressure may cause its obliteration, but success in this direction is more likely to be obtained by removing a portion of the cyst wall, and lightly packing its interior.

DERMOID CYSTS.—These form slowly-growing painless tumours. They may attain large size, and careful palpation may then detect fluctuation. They are closely connected with the superficial variety described under “Diseases of the Eyelids,” the only difference being that they arise in a somewhat deeper portion of the embryonic fissure of the orbit. Sutton‡ points out that dermoids arising on the inner side “may extend beyond the bone, and lie in intimate connection with the dura mater. It is very necessary to remember this in attempting the extirpation of the dermoid. In some cases the tumour may have a peduncle continuous with the dura mater. Under such conditions the dermoid may transmit the cerebral pulsation; it is then apt to be mistaken for a meningocele. This is a less serious error than mistaking a meningocele for a dermoid and following up the error by attempting its extirpation.” The differential diagnosis between a

* ‘Trans. Ophthal. Soc. U. K.,’ vol. xiii, p. 118.

† Idem, vol. xiv, p. 190.

‡ ‘Tumours; Innocent and Malignant,’ 2nd edit., p. 365.

dermoid and a meningocele has already been discussed (*see* page 515). It may be impossible to differentiate between a dermoid and a parasitic cyst, but the history of the case will probably afford a good clue, and in any case an exploratory incision will clear up the diagnosis.

PARASITIC CYSTS.—Hydatids and cysts due to the *Cysticercus cellulosæ* are the two most frequent varieties. They form slowly-growing tumours, in which fluctuation will probably be detected. C. S. Bull* states that ciliary neuralgia is an almost constant feature of echinococcus cysts; but with this exception these growths cause no symptoms beyond those referable to pressure upon and displacement of the globe. A parasitic cyst is most likely to be confused with a dermoid, and, as pointed out in the preceding section, an exploratory incision may have to be made before the case is cleared up. No mistake is likely to be made in differentiating it from a meningocele if due care is taken.

Treatment of Dermoid and Parasitic Cysts.—The most satisfactory method is to dissect them out, but this is often extremely difficult, and occasionally impracticable without sacrificing the eye. In some cases it may be convenient to freely divide the external canthus so that the lids may be turned either upwards or downwards, and thus the outer boundary of the orbit be completely exposed; or in deeply-placed tumours Krönlein's operation (*see* page 521) may be performed. A great difficulty is that they sometimes so entwine themselves amongst the orbital muscles that it is hard to follow them; and their walls are frequently so thin that they either give way or are punctured during the operation, and their contents having escaped, it becomes almost impossible to identify them from the structures in which they are buried.

When dealing with large or deeply-placed cysts not amenable to dissection, and the eye is visually good, a portion of the cyst wall may be removed and the cyst emptied as far as possible of its contents, after which it may be lightly packed with lint and the cavity drained, in the hope of obtaining its obliteration. Even if successful in this object this method is unsatisfactory, as adhesions will probably form in the orbit, which will cause permanent limitation of movement of the globe or a squint with troublesome diplopia.

c. Periosteal Tumours.

(i) **FIBROMATA** usually grow from the periosteum of the orbit, to which they are attached by either a broad or pedunculated base. They are often situated near the edge of the orbit, from which with care they may be removed without injury to the eye. These tumours, when carefully dissected out with the portion of the periosteum from which they have sprung, do not reappear.

(ii) **EXOSTOSES** or **OSTEOMATA** grow commonly from the inner wall of the orbit. They not infrequently arise primarily in the frontal or ethmoidal sinus, and occasionally spring from, or extend their growth into the anterior cranial fossa. The dense variety known as the

* 'System of Dis. of the Eye,' vol. iii, p. 44 (Norris and Oliver).

ivory exostosis is that most commonly met with. It forms a very slowly growing, painless tumour of stony hardness and complete immobility, sometimes pedunculated, but more often sessile with a smooth, broad base, that makes removal in such cases a very extensive and difficult operation. By attention to these points the diagnosis will probably be made without difficulty, though occasionally some care may be required to distinguish it from a chronic distension of the frontal sinus (*see* page 524).

Treatment.—As a rule these tumours are best left alone. Their structure is often so dense and the base so extensive that complete removal is impossible, and further, when the orbital roof is involved, the possibility of opening up the anterior cranial fossa in the removal must not be forgotten.

If it is decided to attack one of these tumours the surgeon must be provided with bone forceps, a bone chisel, a gouge, and an elevator; and, in addition, an Archimedean drill may be useful, with which the base may be tunnelled in various directions, as in a case reported by Tweedy.*

The latter was a peculiarly instructive case, as the patient did well for a month and then suddenly developed symptoms of meningitis, which proved rapidly fatal. At the *post-mortem* examination it was found that the greater part of the growth was lodged in the anterior cranial fossa.

THE MALIGNANT TUMOURS that originate in the cellular tissue or periosteum of the orbit are invariably sarcomata. Various histological types, including melano-sarcoma, may occur, but perhaps the most frequent are spindle or round-celled growths springing from the periosteum. Carcinoma may spread from the eye or one of the adjacent cavities, but it never commences primarily within the orbit. The malignancy of orbital sarcomata is variable; in some cases the tumour rapidly infiltrates the adjacent tissues, and local or metastatic recurrences quickly appear, even after early and apparently complete extirpation; on the other hand, the tumour may for a considerable time be of slow growth, and when removed be found completely encapsuled, and capable of being shelled out of its bed like a lipoma.

Diagnosis.—These malignant tumours have to be diagnosed from benign growths, from tumours of the lacrymal gland and optic nerve, and from tumours originating in the eye or adjacent parts which have spread to the orbital tissues. In the first place it is to be remembered that sarcoma is by far the most frequent form of solid orbital growth; and secondly, that a differential diagnosis cannot always be made even with the greatest care. Bearing these two facts in mind, and the axiom that the successful treatment of a malignant growth depends largely upon an early and complete removal, the surgeon should not, in cases of doubt, wait to establish a diagnosis by watching the progress of the case, but should at the earliest moment make an exploratory incision into the orbit (*see* page 519), and be prepared to act according to what is found.

* 'Royal Lond. Ophth. Hosp. Rep.,' vol. x, p. 303.

A long-standing history; the presence of true fluctuation in the case of a cyst, which must be carefully distinguished from the pseudo-fluctuation so common in a soft sarcoma; and the intense hardness and immobility characteristic of an exostosis, are points to bear in mind. Not much can be said as to age, but the appearance of a solid orbital growth before puberty certainly increases the probability of its being malignant. Tumours of the lacrymal gland are exceedingly rare, and will be sufficiently indicated by their position. From a tumour of the optic nerve or its sheath a differential diagnosis may be impossible, but two facts may be remembered: firstly, that optic nerve tumours mostly occur in early childhood; and secondly, that they usually produce white atrophy of the nerve and blindness before exophthalmos, whereas in an orbital sarcoma the reverse is the case.



FIG. 246.—A case of melanotic sarcoma of the orbit which has ruptured through the globe and has filled the orbital cavity. The chloride of zinc paste was applied in this case after extirpation of the orbital contents, as recommended on page 521. Some years later the patient was alive and well.

Tumours originating primarily in the eyeball can usually be distinguished by careful examination from those commencing in the orbital tissues, but not always, because a choroidal sarcoma may cause the lens to become cataractous so as to prevent the internal examination of the eye, and there may be no external evidence or increase of tension to denote the presence of a growth within. From tumours of the third class, or those which originate in adjacent cavities, there are usually abundant clinical signs by which a differential diagnosis may be made.

Treatment of Malignant Tumours of the Orbit.—There is only one right method of dealing with a malignant tumour of the orbit, and that is the total extirpation of the orbital contents at the earliest possible moment. Even though the eye possesses useful sight, this must not be held to weigh against the danger to life which is involved by an incomplete removal; and, in our opinion, all attempts to preserve the eye and dissect out the growth are strongly to be condemned.

When there is doubt as to whether an orbital growth is malignant or not an exploratory incision should be made through the upper or lower lid, whichever affords the better chance of examining the growth. The lid is divided by a curved incision close to and following the line of the orbital margin, and the incision is made of sufficient extent to permit of the finger being passed into the orbit and the examination of the growth by palpation.

Class 2.—Tumours which commence within the Eye and afterwards extend to the Orbit, or reappear in the Orbit after the Eye

has been excised.—To this class belong the malignant diseases of the uveal tract and retina. They are discussed in the chapters devoted to the diseases of these structures.

Class 3.—Tumours which have their Origin at some Site beyond the Eye or Orbit, but have extended into the Orbital Cavity.—Such growths may spring from the antrum, the frontal sinus, the lacrymal canal, or from some of the bones which help to form the base of the skull, such as the pterygoid processes or the body of the sphenoid. Their treatment does not come within the scope of this work.

Exenteration or Extirpation of the Orbital Contents.—By many surgeons the operation is performed by a circular incision through the fornix of the conjunctiva of the lids, the latter being thus preserved intact. There is, however, no object in preserving the lids or any part of the conjunctival sac, and it is better not to do so, for the former always become indrawn during the healing process and may form pockets for the accumulation of discharges, whilst the Meibomian and sebaceous glands continue their secretions, which form constantly recurring crusts and scales upon the lashes.

The surgeon stands preferably in front of the patient at the side upon which it is proposed to operate, and starting from the outer side in the case of the right eye, and from the inner side in the case of the left eye, he makes a sweeping incision with a good-sized scalpel round the orbital margin, taking care to drag the skin upwards with his disengaged hand as he performs the upper part of the incision, and downwards as the knife traverses the lower orbital margin. In this way the cut edge of the skin will be placed well over the orbital margin,

and no raw surface will be exposed. This first incision should completely divide the lids and open up the orbit, after which a dissection is easily and quickly made by dragging the orbital contents first in one direction and then in another, so as to expose the orbital walls to the scalpel, which is passed deeply into the cavity, and completes the separation as far as the apex. As soon as this has been done, the scalpel is laid aside, and the cone of tissues at the apex is divided by a few snips with a pair of strong scissors curved on the flat.

It should be remembered that the orbital plate of the frontal



FIG. 247.—Orbital bones as they came away in one piece after the application of the chloride of zinc paste. The case was one of malignant tumour of the orbit, and eighteen years later the patient was well, and had had no recurrence of the disease.

bone is frequently thin and soft from the pressure of the growth against it. Special care should therefore be taken during the operation to

avoid applying force with any instrument against the roof of the orbit. Twice the author has been present when cerebral matter was brought away with portions of the tumour during the operation.

The hæmorrhage, which is usually rather free, is easily arrested after removal of the mass of tissues by pressure and plugging, but before applying dressings, examination should be made of the cavity, and any ragged pieces left behind should be carefully removed with scissors and forceps.

If examination shows that the periosteum is involved, it should be incised round the orbital margin and then stripped off, it being easily detachable except at the apex, where scissors will be required to divide it. Short of this, examination of the malignant growth may show that there is but little free margin of healthy tissue surrounding it at one or more spots. The walls corresponding to these places should be then well seared with the actual cautery, or, what is still more efficacious, the chloride of zinc paste (F. 6) spread on small pieces of linen should be applied to them, and left in contact for ten or twelve days until the resultant sloughs have separated.

The after-treatment of these cases is important. There is a certain risk of meningitis unless the cavity is kept sweet and clean. Before the days of aseptic surgery septic meningitis carried off a number of patients after this operation, and therefore for the first ten days the tampons of aseptic gauze or lint, which should lightly plug the cavity, should be removed daily and the cavity freely irrigated. Daily dressing is especially indicated for the first few days because a certain amount of oozing occurs after the operation, and even with care it is difficult to prevent some decomposition when there is blood-clot pent up in the orbit. After ten days or a fortnight, if thought advisable, a second operation to cover the bony walls with Thiersch grafts may be undertaken. By this means a perfectly clean and dry cavity is obtained, and healing is also considerably expedited.

Krönlein's Operation for the Exploration of the Orbit.—This consists in the resection of the outer orbital wall, which is exposed by an incision curved with the convexity towards the eye, the summit of the curve reaching nearly to the outer canthus and the incision sufficiently sweeping to include the outer orbital margin. The incision is at once carried down to the bone and the latter cleared by a few strokes with the scalpel. The periosteum lining the outer orbital wall is now detached with a raspatory and is pulled inwards by a retractor, which also serves to protect the globe and other structures during the resection of the bone. A wedge-shaped portion of the outer orbital wall is now cut through with a sharp bone chisel and hammer by two incisions, converging so as to meet in the spheno-maxillary fissure. This wedge of bone, measuring about one and a half inches in length and about one inch in depth, is then gently dislocated and tilted backwards against the soft tissues behind, and the detached periosteum having been incised, an excellent view is obtained of the orbital contents, with sufficient space to allow of a dissection or of a more thorough examination of an orbital growth than can be obtained by any other method. The

operation is completed by re-adjusting the wedge-shaped piece of bone, and by the application of sutures.

One drawback to the operation is that adhesions may form during healing and cause limitation of ocular movements, and the external rectus is especially liable to become slightly bound down, with the result that an external squint and perhaps a troublesome diplopia may develop.

DISTENSION OF THE FRONTAL SINUS.

The frontal sinus may be distended with pent-up secretion (**mucocele of the frontal sinus**) or pus (**empyema of the frontal sinus**), and the tumour thus formed may so closely resemble a growth from within the orbit as to render it difficult to arrive at a correct diagnosis without making an exploratory incision. In order to rightly estimate the displacement of the globe which an expanded frontal sinus may produce, it will be necessary to refer briefly to the anatomy of the dry skull.

The frontal sinuses do not appear until about the seventh year, being formed later than the anterior ethmoidal sinuses, of which they are extensions, and which make their appearance about the third year. They consist of two bony cavities placed between the inner and outer tables of the vertical portion of the frontal bone, and are completely separated from each other by a bony septum. Each of these spaces is subdivided into cells by delicate lamellæ of bone. These cells extend upwards about one inch, gradually becoming narrower as they ascend, until the opposed plates of the frontal bone come almost into contact, only a thin layer of diploë intervening. Forwards and outwards the frontal cells are prolonged between the layers of bone which form the roof of the orbit as far as the mesial line of that cavity, at which part they cease, from the opposed laminæ of bone falling together. The half cells which are seen in the dry frontal bone at the nasal notch are completed by corresponding half cells on each side of the cribriform plate of the ethmoid bone. The frontal cells communicate with the middle meatus of the nose by means of the infundibulum, which is a long and tortuous bony canal connecting the anterior ethmoidal cells with the frontal sinus above, and with the meatus of the nose below.

The situation of the frontal sinuses is indicated on the exterior of the frontal bone by two prominences over the root of the nose, more or less strongly marked in all people, and called the nasal eminences.

Such being the disposition of the frontal cells, it is easy to conceive in what direction a new growth, or an accumulation of fluid, would cause them to distend. Of their boundary walls the weakest is that towards the orbit, where the bony plate which separates that cavity from the frontal sinus is exceedingly thin, and often in the dry skull semi-transparent; so delicate, indeed, in structure is the upper and inner part of the orbit, that the finger, in many of the dry preparations, may be easily pushed through it.

Ætiology and Pathology.—In most cases, distension of the frontal sinus is due to an injury at some remote period, frequently at a date so

long before the symptoms which first attract the patient's notice, that it seems at first difficult to fairly conclude that the disease is the result of the accident. The extent, however, to which the sinus is often found dilated, and the time which must necessarily be occupied in effecting this distension of a bony cavity, together with the oft-told tale of a blow or a fall years ago, can only lead to the conclusion that an injury is the most frequent exciting cause of these accumulations. The explanation is probably to be found in the supposition that at the time of the accident a fracture of some of the anterior ethmoidal or frontal cells produced a closure of the infundibulum, the canal by which the mucus from the frontal sinus escapes into the nose. This channel being closed, there is at once a retention of all mucous secretion, which from that time slowly accumulates and gradually expands the sinus.

There are, however, cases of distended frontal sinus in which no history of an injury can be traced. The only conclusion which can then be drawn is that, from some accidental cause which we cannot detect, the communication between the frontal cells and the nose through the infundibulum has been closed, possibly from some inflammation of the lining mucous membrane.

The distension is most commonly confined to one side, but occasionally both sinuses are affected. According to C. S. Bull* the left sinus is more frequently attacked than the right, and he also notes that the disease occurs with greater frequency in men, and this he regards as being due to the sinus being more developed, and the infundibulum wider in men than in women, so that infective material is more easily transmitted. The anterior ethmoidal sinuses may become secondarily affected, or the distension may, in some cases, commence here; but in either case there are no special symptoms referable to this point, beyond the extension of the swelling along the inner orbital wall as well as the upper and inner orbital angle.

Symptoms.—Distension of the frontal sinus may be *acute* or *chronic*.

When the distension is **acute**, it is due to inflammation of the mucous membrane of the sinus, which leads to the formation of pus. There is generally a dull aching pain over the brow and root of the nose, accompanied by considerable constitutional disturbance. The pus gradually accumulates in the frontal sinus, and ultimately discharges itself either by bursting into the nose or by making an exit for itself through the upper and inner part of the orbit. When the latter site is selected, there is usually some bulging of the distended sinus into the orbit, and a slight displacement of the eye downwards and outwards. The upper lid becomes red and swollen, and the tumour, examined with the finger, is tender, and will, if sufficient thinning of the bone has taken place, impart a sense of fluctuation.

In most cases the distension of the frontal sinus is **chronic**, and the collection of fluid within its walls is the pent-up secretion of many years. Sealed within a bony cavity, no decomposition ensues, and

* 'System of Diseases of the Eye' (Norris and Oliver), vol. iii, p. 52.

increasing year by year in quantity, it distends the sinus and displaces the eye. There is frequently no pain, not even a sense of weight over the brow. The only symptoms which are manifest to the patient are the gradual formation of a tumour at the upper and inner portion of the orbit, and a slow but steadily increasing displacement of the eye downwards, outwards, and a little forwards; but protrusion of the eye is usually much less marked than the lateral displacement. In one patient under the author's care (Fig. 248) the displacement was so extreme that the upper margin of the cornea of the *left* eye was below the level of the *right* lower lid. Occasionally the early symptoms are chronic, whilst the later ones are subacute and productive of a feeling of constant heaviness and aching across the forehead.

Diagnosis.—From lacrymal abscess or obstruction the disease is easily recognised by its situation *above* the tendo oculi, by the displacement of the eyeball, and by the absence of epiphora or regurgitation of muco-pus along the canaliculi on pressure applied to the tumour.



FIG. 248.—A case of enormous distension of the frontal sinus clearly traceable to a kick from a horse received many years before. This block should be compared with Fig. 202. The frontal sinus was opened and drained through the nose, and the patient did very well.

In chronic cases the differential diagnosis from an osteoma may be very difficult. Both may equally present a slowly growing painless tumour at the upper and inner angle of the orbit, causing downward and outward displacement of the globe. A frontal sinus distension with its thin wall will probably, however, not yield the feeling of stony hardness characteristic of an osteoma; at one point it may crackle or yield slightly to pressure, and firm palpation or percussion over the tumour or frontal eminence may cause the patient to wince.

So, too, it may be difficult, perhaps impossible, to decide whether we have to deal with a

fluid distension of the sinus or a malignant tumour pushing its way into the orbit; but the growth of a malignant tumour will be far more rapid than is usually the case with fluid distension, and it is apt to be accompanied by severe pain, from which the latter is generally free.

If the bony wall of the orbit has been absorbed so that fluctuation is obtainable, a diagnosis has to be made from a meningocele or a dermoid cyst. The former can scarcely cause difficulty, for, in addition to the special features of a meningocele, there will be the history of its having existed since birth, which would put frontal sinus disease out of the question. The latter point may apply to a dermoid,

but a congenital history cannot always be obtained in this class of growth, and sometimes a dermoid remains quite small till after puberty. In a dermoid, however, exophthalmos is likely to be as pronounced as lateral displacement of the globe, whereas in frontal sinus distension there is very little forward bulging of the eye.

Thus it will be seen that under certain conditions a positive differential diagnosis may be impossible without proceeding to a puncture of the swelling or an exploratory incision, which should be undertaken without hesitation in all cases of doubt.

Treatment of Distension of the Frontal Sinus.—The objects to be attained are, firstly, to evacuate the pent-up fluid, and secondly, to establish a free communication between the frontal sinus and the nose, through which the secretion may continue to drain as fast as it is secreted. By these means the cavity of the sinus will gradually collapse, and the eye will be restored in a great measure to its normal position. The ends to be desired will be accomplished by the following **operation** :

A single curved incision parallel with the fold above the lid is to be made over the most prominent part of the tumour, and having by a little dissection exposed its surface, the scalpel should be plunged into it, and an opening made to the extent of the incision. The index finger of the right hand is now to be pushed into the sinus through the wound to ascertain the size of the cavity, and if there is any necrosed or carious bone. Whilst thus exploring the sinus the little finger of the left hand should be passed up the corresponding nostril, and an endeavour made to find out the spot at which the tip of the finger in the sinus will approximate most closely to the end of the one in the nose. After a little search it will be found that at one part the fingers will almost meet, there being only a thin plate of bone between them. Having gained this information, the finger in the frontal sinus is to be withdrawn, but that in the nostril is to be retained *in situ* to act as a guide to the gouge or elevator, which is to be passed into the sinus and made to force a passage into the nose through the lamina of bone on which the tip of the little finger is resting. A communication between the frontal sinus and the nose having been thus established, an india-rubber drainage-tube with holes cut at short distances is to be introduced, one extremity of which is to be afterwards fastened on the forehead, whilst the other end protrudes slightly from the nostril.

The easiest way of introducing the drainage-tube is to pass a probe with an eye up the nostril and out of the wound, and having fastened the tube to it by means of a piece of silk, to draw it back again through the nose.



FIG. 249.—This figure shows the method of draining the frontal sinus.

The object of the drainage-tube is to keep the channel between the two cavities from closing, and to enable the attendant to wash out the frontal sinus at least twice a day with some astringent and disinfectant solution. The drainage-tube should be worn for five or six months, or until all discharge from the nose has ceased. The results of these cases when thus treated are usually most satisfactory.

EXOPTHALMIC GOITRE—BASEDOW'S DISEASE—GRAVES' DISEASE.

Though the treatment of this disease scarcely comes within the province of ophthalmology, still a brief outline is necessary, as the eye symptoms are often those that first attract the serious attention of patient and friends, and consequently the ophthalmic surgeon is frequently consulted with regard to them.

The main characteristics of the disease are four in number, namely, exophthalmos, enlargement of the thyroid gland, tachycardia with palpitations of the heart, and fine tremors affecting the extremities. To these may be added anæmia, derangement of the functions of one or more of the visceral organs, and a peculiar capriciousness of temper; but these signs are not characteristic, inasmuch as they are common to other diseases.

Ætiology and Pathology.—Of the direct causation of the disease we have as yet no positive knowledge. Females are much more frequently attacked than males, and the largest number of cases occur during the period of active menstrual life, the disease being rare in childhood and in women over fifty years of age. It has been frequently noted that its onset is in many cases preceded by some shock to the nervous system, such as a severe fright, or by a prolonged mental strain induced by overwork, anxiety, etc. Sometimes a family predisposition has been evident, and sometimes the disease is associated with hysteria or other forms of nervous disorder, either in the patient or in the near relatives.

The relationship of the symptoms to any observed lesion has been, and is still, the subject of much discussion. Some symptoms, notably those referable to the eye, point especially to an irritative affection of the cervical sympathetic (*see* page 393), and swelling of the ganglia has been described; but it can scarcely be said that any lesion peculiar to this disease has been noted, nor can any such theory be made to account for all the other symptoms which are seen. By many, a diseased condition of the thyroid gland is held to be the primary factor, and there are several reasons to justify this conclusion. For example, the contrast afforded by comparing the condition of a patient suffering from myxœdema with another affected with exophthalmic goitre is very suggestive of hypersecretion or excess of function being the causal agency at work in the latter disease. Again, anatomically the enlargement of the thyroid gland is in a great measure due to an increase in the glandular elements, which is accompanied by a large increase in vascularity. An abnormal output of thyroid secretion may be reasonably inferred, and recent experimental investigations by Walter

Edmunds* have shown that in monkeys the ocular symptoms of exophthalmic goitre may be induced by the administration of large doses of sheep's thyroid.

Examination of the heart frequently reveals nothing abnormal. The palpitations in the early stages seem to be purely functional, though later on some dilatation not infrequently ensues.

A curious feature of the disease, for which at present no satisfactory explanation is known, is the frequent persistence of the thymus gland.

Symptoms.—Ocular Symptoms.—The exophthalmos nearly always affects both eyes, and generally to an equal extent. Occasionally unilateral exophthalmos occurs, and one such case has been recently under our care. As the disease advances the bulging increases, sometimes to such an extent as to prevent the lids from closing over the globe. When this happens the eyes suffer from exposure, and become liable to frequent attacks of inflammation, which may go on to suppuration of the corneæ and destruction of the sight. If, however, this inflammation is avoided, the protrusion may become very great without affecting vision. The exophthalmos is always accompanied by other ocular phenomena, which have received special names from the writers who first described them.

a. Graefe's sign consists in the loss of the associated movement of the upper lid and the eye in downward rotation of the globe. In health this movement of the lid is exactly proportioned to and contemporaneous with the movement of the eye; but in exophthalmic goitre the lid movement is carried out in a jerky and unequal manner, so that as the eye follows the movement of a finger held before it, there is at one time more of the sclerotic exposed than at another.

b. Stellwag's sign consists in a marked diminution of the normal reflex act of winking, apparent not only in its diminished frequency, but in the incompleteness of the reflex.

c. Dalrymple's sign is the widening of the palpebral fissure, due to a retraction of the upper lid.

Convulsive spasm of the orbicularis, which may be severe enough to dislocate the globe, is a rare and painful symptom.

Thyroid Symptoms.—The enlargement is usually of moderate degree and uniform, but occasionally one lobe is larger than the other. Pulsation is always apparent, frequently accompanied by a distinct thrill, and with the stethoscope placed over the gland a loud venous hum is heard.

Cardiac Symptoms.—The rapidity of the pulse is very variable. The rate increases very much under the influence of the slightest flurry or excitement, but as a rule it numbers well over 100 beats per minute, and may be so rapid that it cannot be counted. The accompanying palpitations form a very distressing feature to the patient, and are often the symptom about which complaint is first made. They increase with the advance of the disease, are aggravated by mental emotion or exercise, and sometimes produce paroxysms of breathlessness accompanied by throbbing and a sense of fulness in the eyes.

General Symptoms.—The tremors are best observed by making

* 'Trans. Ophth. Soc. U. K.,' vol. xx, p. 243.

the patient hold out the hand with the fingers extended. The movements are very fine, and vary according to the mental condition of the patient at the time of examination. The appetite is variable, at one time good, at another almost wanting. The bowels are irregular in their action, one patient suffering from repeated attacks of diarrhoea, whilst another is troubled with flatus and constipation. Anæmia frequently attends the disease, and disorders of menstruation, especially amenorrhœa, are very common. Emaciation is observed in acute cases, and must be regarded as an unfavourable symptom.

Diagnosis.—This is quite straightforward when the cardinal symptoms are all present, and needs no discussion here.

Prognosis.—The disease, as a rule, tends to become chronic, and may persist for many years, the patient being now better, now worse. After a variable lapse of time a permanent amelioration is established in the majority of cases, though frequently some exophthalmos and enlargement of the thyroid gland persist. Some cases, however, run a more rapid and satisfactory course, resulting in a perfect cure after the lapse of some months; whilst in a small percentage the symptoms become acute, progressive emaciation sets in, and the patient dies from asthenia.

Treatment.—In view of the cardiac symptoms, all forms of emotional excitement, such as dancing, theatres, etc., should be forbidden, and the degree of physical exercise indulged in should be strictly regulated. Internally, belladonna and bromides are useful nerve sedatives, whilst digitalis and strophanthus are indicated for the cardiac condition. We have frequently prescribed the Tinct. Bellad. $\mathfrak{m}\mathfrak{x}$ with the Tinct. Digitalis $\mathfrak{m}\mathfrak{v}\mathfrak{i}\mathfrak{i}\mathfrak{j}$, three times daily, and usually with good results. The iodide of potassium generally fails to do good in these cases; it depresses too much, and frequently induces iodism. From the usually anæmic state of the patient, iron would naturally be suggested, but with the rapid pulse which mostly accompanies this disease the drug is badly borne, and aggravates the symptoms. During the paroxysms of dyspnœa ice should be applied over the thyroid and over the præcordial region in an india-rubber ice-bag, and the tincture of digitalis $\mathfrak{m}\mathfrak{x}$ to $\mathfrak{m}\mathfrak{x}\mathfrak{v}$ prescribed every two or three hours, keeping a careful watch over the patient during its administration. If there is habitual constipation the bitter waters of Pullna, Friedrichshall, or Kissingen may be also prescribed. In cases which have resisted medicinal remedies a course of hydropathy is well worth a trial, with the hope of obtaining relief by inducing a free action of the skin. Thyroid feeding has often been tried, but in view of our present knowledge it is distinctly contra-indicated, and we have never found it of the slightest service. When the exophthalmos is severe the eyes must be protected from exposure by the wearing of curved, tinted glasses. Ulceration of the cornea must be treated on the lines laid down in the article discussing "Ulcers of the Cornea," page 144.

Of late years operative measures have been suggested and carried out in a fair number of cases. Removal of a portion of the thyroid gland has been performed many times, and Starr* has published

* 'Med. News,' N.Y., vol. lxxviii, p. 427.

statistics of 190 of such operations. The results have been very favourable in a large number, but it is questionable whether they warrant the operation, which proved fatal in about 12 per cent., especially when it is remembered how large a proportion of these cases improve very materially under non-operative treatment. Jaboulay* has practised division of the cervical sympathetic in a few instances, in all of which benefit followed, but it is at present too soon to speak decidedly as to this method of treatment.

* 'Lyons Méd.,' 1896 and 1897.

APPENDIX.

The Local Vitality of the Conjunctival Sac.—The conjunctival sac is constantly exposed to contamination from without by particles of dust and all varieties of extraneous material. It is also in danger of infection from the nose by means of the lacrymal passage, and organisms which have obtained an entrance are apt to be fostered in its recesses by its peculiar anatomical conformation. For these reasons the conjunctival sac has been very generally regarded as a species of anatomical sink, teeming with all manner of micro-organisms. The reverse is the actual case, and the conjunctival sac is singularly devoid of, at any rate, living bacteria.

The writer has made an exhaustive bacteriological examination of 200 healthy conjunctival sacs, and the results were very striking.* Forty-one of the 200 inoculated tubes were found absolutely sterile, and many more only presented a few discrete colonies. The conjunctival sac may possibly never be quite sterile, although we personally believe that this is frequently the case; but, at any rate, the sterility of these 41 tubes indicated that living micro-organisms were few and far between. Indeed, one of the most striking features of our observations was the small number of colonies in the large majority of those tubes in which bacteria were found, and the only micro-organism which occurred plentifully was the so-called xerosis bacillus, which is absolutely non-pathogenic. The latter bacillus was found in 118 of the 200 primary tubes, or in 74 per cent. of the 159 fertile tubes, and in 90 cases it occurred in pure culture as the only living organism found. Pyogenic cocci were only found in 16 tubes, and with one exception the number of colonies were few. Inoculations of fresh peptone broth cultures of these pyogenic cocci were made into the conjunctival sacs of guinea-pigs and rabbits, but invariably a negative result followed. The pyogenic bacteria included the *St. pyogenes aureus*, *albus*, *citreus* and *cereus albus*, together with the pneumococcus of Fraenkel.

It is to be further remarked that other observers, such as Leber and Fick, have failed to obtain growths of any description in a certain number of inoculations from the healthy conjunctival sac, and that

* 'Trans. Jenner Inst.,' vol. i, p. 56.

Leber, Weeks, and others have inoculated the *St. pyogenes aureus* into the healthy human conjunctival sac without any result.

In the face of these facts it is impossible to avoid the conclusion that the conjunctival sac, probably chiefly by its epithelium, but possibly also in part by means of the lacrymal secretion, exerts a remarkable and detrimental influence upon the life and growth of bacteria.

The importance of ensuring a healthy condition of the conjunctival sac before undertaking an intra-ocular operation can, therefore, be scarcely over-estimated. After all such operations it is necessary to occlude the eye for some days, and the presence of decomposing discharges from conjunctivitis, trachoma, or mucocoele pent up within the closed lids is very liable to bring about a septic infection of the wound, whereas, as we have already shown, there is nothing to fear from the contents of a normal conjunctival sac.

Any affection of the conjunctiva or lacrymal apparatus must therefore be energetically treated, and operation, except in cases of emergency, such as acute glaucoma, should be postponed until the condition is relieved. In cases of doubt it is a good plan to occlude the eye for twelve hours by a pad of dressing and a bandage, and if at the end of this time there is no gumming together of the lids and no discharge on the dressing or lashes, we may conclude that all is well.

It may happen, as above-mentioned, that we are called to operate suddenly on a patient who incidentally is also suffering from an acute inflammation of the conjunctiva. In such a case the sac should be well swabbed out with a ten-grain solution of nitrate of silver before proceeding to operate, and subsequently the bandage must be removed once or twice daily, according to the necessities of the case, to free the sac from accumulated discharges by gentle irrigation, and for the occasional application of astringents.

Preparation of a Patient for a Major Intra-ocular Operation.—

The urine should always be examined as a routine. The presence of albumen or sugar might cause us to defer operation for a time. The bowels should be well opened by an aperient on the previous day, and it is a good plan to further order a simple enema on the evening preceding operation. After an intra-ocular operation it is desirable to keep the patient as quiet as possible for a day or two, and to avoid all straining at stool, so that the complete evacuation of the lower bowel before operation is a point of some importance.

The best time for performing intra-ocular operations is undoubtedly the morning, and this for several reasons. In the first place, the light is then generally at its best. Secondly, patients as a rule have a great dread of operations on the eye, and if the operation is carried out in the morning, soon after a night's rest, they have less time to become nervous, and are consequently less liable to lose their self-control when only a local anæsthetic is to be used, as is usually the case. Thirdly, there is always a period of some pain after the effects of

cocaine have worn off. It lasts normally but a few hours and is not excessive, so that if the operation is performed in the morning, the evening will generally find the patient free from discomfort and able to enjoy a good night's rest.

Treatment of the Patient after a Major Intra-ocular Operation.—Special details with regard to local treatment have already been mentioned after the description of the major intra-ocular operations, and only two points need be mentioned here. Firstly, it is advisable for the patient to be kept strictly on his back for the first few days, and the evacuation of the bladder and bowels should be carried out when in this position. Many patients have, however, a great difficulty in doing so, and when this is the case it is far wiser to let them sit up or use the night-stool than to strain ineffectively on their backs, and they are much less likely to do themselves harm. Secondly, cataract patients are usually past middle age, and strict confinement to the horizontal position may induce some static congestion of the lungs. The surgeon should always be on the look-out for this, and on the earliest indication of a cough or rise in temperature it is wisest and safest to allow the patient to sit propped up in bed or in an armchair.

Antiseptic Solutions.—From what has been already said with regard to the normal bacteriological condition of the conjunctival sac, it will be gathered that any solution applied to the eye either immediately before or after an intra-ocular operation, with the idea of destroying any stray micro-organisms, is superfluous. Indeed, nearly all germicidal agents, when used of sufficient strength to be of any effective use in this way, do positive harm by irritating the eye and producing a most undesirable congestion. It is a good plan before operation to flush the conjunctival sac with boiled distilled water or an equally non-irritating solution of boracic acid, in order to remove any little impurities that may be clinging to the lashes or lodged in the sac; but such a proceeding can scarcely be said to be necessary, and should be undertaken merely as an extra precaution to obtain the highest degree of cleanliness, and not with any idea of antiseptics.

Dressings.—Only quite simple dressings are required after an intra-ocular operation. An aseptic pad of absorbent wool, bi-cyanide gauze, or one of the other numerous like materials, surmounted by a two-inch roller bandage applied in the manner directed in F. 2, or by the special bandage figured in F. 1 when both eyes are to be occluded, is all that is necessary. Personally we have a preference for Gamgee tissue, which makes a very comfortable even dressing and does not irritate the skin. The pad should be of good size, either circular or U-shaped, and should be large enough to allow pressure to be evenly distributed by the bandage. Some surgeons prefer to hermetically seal up an eye for the first week after an iridectomy or extraction of cataract, but this practice has its dangers. Matters will not always go straight, and the early symptoms of inflammation are often insidious, so that a rude awakening may await the removal of such a dressing.

Instruments.—Greater care is needed than in any other branch of surgery to see that knives, needles, and scissors are duly sharp. Many an operation has been spoilt by a dulled edge or point which would pass muster in general surgery, and before operation every cutting instrument should be carefully tested both as regards point and edge upon a trial drum.

Boiling for two minutes in distilled water, to which a pinch of carbonate of soda has been added, is the easiest and most rapid way of obtaining efficient sterilisation, but it is bad for the cutting instruments, and we must be prepared to have them sent very frequently to be set on the stone if it is employed. Immersion in carbolic (1 in 20) for ten minutes is another and equally efficacious way. In order to protect instruments from contamination during operation the tray containing them may be flushed with a weak sterilised saline solution (75 per cent.) or by plain boiled distilled water. After use, the final cleansing of the more delicate instruments should be carried out with a fine linen or silk handkerchief, as an ordinary towel is very apt to catch the point of a knife or needle and to ruin it for further use.

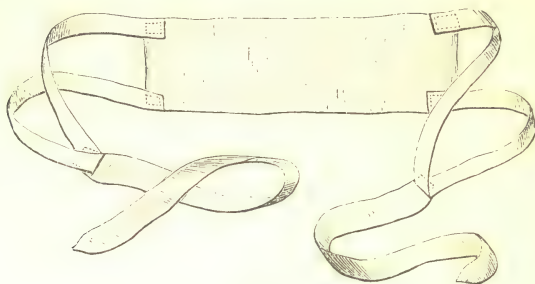
Local Anæsthetics.—Only two drugs require special consideration, *viz.* the hydrochlorides of cocaine and eucaine-beta (β -eucaine). A third drug, *viz.* **Holocaine**, has been extensively tried for the same purpose, but is not so generally useful as either of the others. It induces a rapid anæsthesia, but it is more toxic than either of the other two; it is rather uncertain in its action, favours hæmorrhage, and its instillation causes more discomfort than cocaine.

Cocaine Hydrochloride is the local anæsthetic in most general use. As a drug it has this great advantage over eucaine, *viz.* that it is very useful for a variety of conditions other than the promotion of anæsthesia. Its anæsthetic properties are no greater than those of eucaine, but it acts more quickly, and is a good vaso-constrictor, tending to limit hæmorrhage. Its disadvantages are that it dilates the pupil, and, if used too freely, causes slight desiccation of the corneal epithelium. It is most usually employed as a 2 per cent. aqueous solution, and one drop instilled every three minutes for a quarter of an hour will render the extraction of a cataract almost painless. It is a good plan when inducing anæsthesia for an intra-ocular operation to instil one or two drops into the second eye.

Beta-Eucaine Hydrochloride is closely allied chemically to cocaine, and its anæsthetic properties are very similar. It is, however, rather slower in its action than cocaine, and its immediate effect is to cause greater smarting and discomfort than the latter drug. The advantages it possesses over cocaine are that boiling does not affect its solutions, and it is therefore easily sterilised; it does not dilate the pupil nor affect the corneal epithelium, and the induced anæsthesia is generally said to be more persistent. Another advantage is that it is far less toxic than cocaine, and is much better suited for hypodermic injection than is the latter. It is generally employed as a 2 per cent. aqueous solution, and m_x to m_{xx} of a 2 per cent. solution may be safely injected under the skin for the removal of superficial growths.

FORMULARY OF REMEDIES USEFUL IN DISEASES OF THE EYE.

1. The "Moorfields" Eye Bandage for occluding both eyes.



THIS bandage consists of a central band, made of a fold of linen from $9\frac{1}{2}$ to 10 inches in length, and from $2\frac{1}{4}$ to $2\frac{1}{2}$ inches in width. At each end of it are attached tapes, which are arranged so as to form loops, which include the

ears when the bandage is applied. These loops terminate in two tapes, which are tied behind the head or brought round again to the forehead. If preferred, both eyes may be occluded by a figure-of-eight bandage.

2. The Compress Bandage.

This bandage should be about $1\frac{3}{4}$ yards in length and 2 inches in width. The eye having been padded, the bandage is to be adjusted in the following manner:—One end is to be applied to the forehead just above the affected eye, and is then to be passed round the head above the opposite ear to the starting-point; thence it is once more carried to the back of the head as before and brought up *below* the ear on the affected side, over the compress, and pinned firmly across the forehead.

3. Mercurial Vapour Bath.

The following is Mr. Henry Lee's description of his mercurial vapour



bath :—"The most convenient calomel vapour bath, and that which is now

generally used, is one which was made at my request by Mr. Blaise. In this apparatus the lamp which sublimes the calomel boils the water at the same time. In the centre of the top, immediately over the wick of the lamp, is a small, separate, circular tin plate, upon which the calomel is placed. Around this is a circular depression, which may be one third filled with boiling water. The apparatus is then placed on the ground, and the lamp is lighted. The patient sits over it with an American cloth cloak, or a mackintosh, or a moleskin cloak fastened round his neck. He thus becomes surrounded by calomel vapour, which he is generally directed to inhale for two or three separate minutes during each bath. In doing this the patient should not put his head under the cloak, but simply allow some of the vapour to escape from its upper part, and breathe it mixed with a large proportion of common air. At the expiration of a quarter of an hour or twenty minutes the calomel is volatilised and the water has boiled away. A portion of the calomel is deposited, together with the condensed vapour of the steam, on the patient's body, and is there to be left. The quantity of spirits of wine used upon each occasion is so regulated that the lamp goes out of its own accord about the same time as the calomel disappears. The patient then gradually unfastens the cloak, and in about a minute he is sufficiently cool to put his night-dress on without much interfering with the very fine layer of calomel which covers his body. He must be particularly told not to wipe his skin, as by so doing he would necessarily interfere with the action of the medicine. Should there be no objection on the part of the patient, he may go to bed in the cloak and sleep in it either for a part or the whole of the night.* Twenty to thirty grains of calomel are sublimed at each fumigation.

* Holmes's 'System of Surgery,' 2nd edit., vol. i, p. 491.

4. Lapis Divinus.

Sulphate of Copper, Nitrate of Potash, and Alum, of each equal parts, in powder, fused in a glazed earthen crucible, powdered Camphor, to the extent of $\frac{1}{50}$ part of the whole, being added near the end of the process. When cold, break in pieces and keep in a closely stoppered bottle.*

5. Diluted Nitrate of Silver Points.

These are made by fusing Nitrate of Potash in various proportions with Nitrate of Silver, thus : †

- No. 1 consists of 1 Nitrate of Silver and 2 of Nitrate of Potash.
No. 2 consists of 1 Nitrate of Silver and 3 of Nitrate of Potash.
No. 3 consists of 1 Nitrate of Silver and $3\frac{1}{2}$ of Nitrate of Potash.
No. 4 consists of 1 Nitrate of Silver and 4 of Nitrate of Potash.

6. Pasta Zinci Chloridi (*Ph. Middlesex Hospital*).

This paste is prepared by first making the Liquor Zinci Chloridi cum Opio,‡ and then adding Flour to render it of a proper consistence, as follows :

℞ Liquoris Zinci Chloridi
 cum Opio fl. oz.
 Farinæ Triticæ gr. 120
Mix smoothly in a mortar and heat over a water-bath until of a proper consistence.

* Squire's Comp. to 'Brit. Pharmacop.,' 17th edit., p. 257.

† Squire's Comp. to 'Brit. Pharmacop.,' 17th edit., p. 113.

‡ *Liquor Zinci Chloridi cum Opio* :
℞ Zinci Chloridi oz. 16
 Pulveris Opii oz. $1\frac{1}{2}$
 Acidi Hydrochlorici . . . fl. dr. 6
 Aquam bullientem . . . ad O 1
Macerate the Opium in 12 oz. of the boiling water for twelve hours, add the acid and filter, then dissolve the Chloride of Zinc in the filtered liquid and make up to 20 oz. with distilled water.

7. Fotus Belladonnæ.

Extract. Belladonnæ . . . gr. 60
To be dissolved in one pint of boiling water and used as a fomentation.

8. Fotus Papaveris.

℞ Capsul. Papav. contus. . . oz. 1
Aquæ destillat. . . fl. oz. 20
Mix, and boil for a quarter of an hour; then strain through muslin.

9. Guttæ Argenti Nitratis.

℞ Argenti Nitratis . . gr. 1 ad gr. 2
Aquæ destillat. . . fl. oz. 1
Misce.

10. Guttæ Atropinæ Sulphatis.

℞ Atropinæ Sulphatis . gr. 1 ad gr. 4
Aquæ destillat. . . fl. oz. 1
Misce.

11. Guttæ Atropinæ cum Cocainâ.

℞ Atropinæ Sulphatis . . gr. 2
Cocain. Hydrochlor. . . gr. 10
Aquæ destillat. . . fl. oz. 1
Misce.

Sometimes produces greater effect in iritis than preceding formula.

12. Guttæ Cocainæ Hydrochloratis.

℞ Cocain. Hydrochlor. . . gr. 10
Aquæ destillat. . . fl. oz. 1
Misce.

13. Guttæ Cupri Sulphatis.

℞ Cupri Sulphatis . . gr. 1 ad gr. 2
Aquæ destillat. . . fl. oz. 1
Misce.

14. Guttæ Daturiæ.

℞ Daturiæ Sulphat. . . gr. 2
Aquæ destillat. . . fl. oz. 1
Misce.

Useful when atropine causes irritation.

15. Guttæ Duboisinæ.

℞ Duboisinæ Sulphat. . . gr. 1
Aquæ destillat. . . fl. oz. 1
Misce.

Useful when atropine causes irritation.

16. Guttæ Eserinæ.

℞ Eserinæ Sulphatis . gr. $\frac{1}{2}$ ad gr. 4
Aquæ destillat. . . fl. oz. 1
Misce.

17. Guttæ Eserinæ cum Cocainâ.

℞ Eserinæ Sulphatis . . gr. 1
Cocain. Hydrochlor. . . gr. 4
Aquæ destillat. . . fl. oz. 1
Misce.

Very useful in *chronic* glaucoma.

18. Guttæ Eucainæ.

℞ Eucainæ (B) . . . gr. 10
Aquæ destillat. . . fl. oz. 1
Misce.

Acts more slowly but is much less toxic than cocaine, and therefore more suitable for hypodermic use.

19. Guttæ Homatropinæ Hydrobrom.

℞ Homatrop. Hydrobrom. gr. 2 ad gr. 4
Aquæ destillat. . . fl. oz. 1
Misce.

20. Guttæ Homatropinæ cum Cocainâ.

℞ Homatrop. Hydrobrom. . gr. 4
Cocain. Hydrochlor. . . gr. 10
Aquæ destillat. . . fl. oz. 1
Misce.

A more speedy and greater dilatation is obtained than by preceding formula.

21. Guttæ Hyoscinae.

℞ Hyoscinae Hydrobrom. . gr. 2
Aquæ destillat. . . fl. oz. 1
Misce.

Useful when atropine causes irritation.

22. Guttæ Physostigmatis Fabæ (Calabar Bean).

℞ Extract. Physostig. Fabæ gr. 1 ad gr. 4
Aquæ destillat. . . fl. dr. 1
Misce.

Often useful when eserine gives much pain, but not so powerful.

23. Guttæ Pilocarpinæ.

℞ Pilocarpinæ Nitratis . . . gr. 2
 Aquæ destillat. . . . fl. oz. 1
 Misce.

Useful in low degrees of increased tension.

24. Guttæ Potassii Iodidi.

℞ Potassii Iodidi gr. 3
 Aquæ destillat. . . . fl. oz. 1
 Misce.

Sometimes useful in recent corneal nebulæ.

25. Guttæ Zinci Chloridi.

℞ Zinci Chloridi . . . gr. 1 ad gr. 2
 Aquæ destillat. . . . fl. oz. 1
 Misce.

26. Guttæ Zinci Sulphatis.

℞ Zinci Sulphatis . . . gr. 1 ad gr. 2
 Aquæ destillat. . . . fl. oz. 1
 Misce.

27. Infusum Abri.

(Infusion of Jequirity.)

This is prepared by pouring 100 parts (12½ fluid ounces of water at 49° C. [120° F.]) on eight parts (one drachm) of powdered Jequirity Seeds, allowing it to stand till cool, and then decanting.

N.B.—The seeds must be fresh.

Useful in trachoma and pannus. The *freshly* made infusion is lightly scrubbed with absorbent wool over lids and cornea after anæsthetising with cocaine.

28. Injectio Pilocarpinæ Nitratis.

℞ Pilocarp. Nit. 5 parts
 Aquæ destillat. 100 parts
 Misce.

Dose 2 to 5 minims.

Sometimes useful in nerve affections.

29. Linimentum Aconiti.

℞ Linimenti Aconiti . . . fl. dr. 4
 Linimenti Saponis . . . fl. dr. 6
 Misce.

30. Linimentum Ammoniaæ.

℞ Liq. Ammoniaæ . . . fl. dr. 4
 Ol. Olivæ fl. dr. 4
 Misce.

31. Linimentum Belladonnæ cum Glycerino.

℞ Extracti Belladonnæ . . gr. 240
 Glycerini fl. oz. ½
 Misce.

32. Linimentum Calcis cum Cretâ.

℞ Olei Lini,
 Liquoris Calcis āā fl. oz. 4
 Cretæ Præparatæ oz. 2
 Misce.

Useful in burns of lids.

33. Liquor Argenti Nitratis.

℞ Argenti Nit. . . . gr. 5 ad gr. 20
 Aquæ destillat. . . . fl. oz. 1
 Misce.

To be applied with a brush to inner surface of inflamed lids.

34. Liquor "Fluorescine."

℞ "Fluorescine" gr. 8
 Sod. Bicarb. gr. 12
 Aquæ destillat. . . . fl. oz. 1
 Misce. Filter

This solution stains corneal ulcers an emerald green.

35. Liquor "Protargol."

℞ "Protargol" . . . gr. 40 ad gr. 100
 Aquæ destillat. . . . fl. oz. 1
 Misce.

Useful alternative solution to silver nitrate.

36. Lotio Acidi Borici.

℞ Acidi Borici . . . gr. 4 ad gr. 8
 Aquæ destillat. . . . fl. oz. 1
 Misce.

37. Lotis Acidi Borici cum Cocainâ.

℞ Acidi Borici gr. 8
 Cocain. Hydrochlor. . . . gr. ½
 Aquæ destillat. . . . fl. oz. 1
 Misce.

A good soothing application.

38. Lotio Acidi Carbolici.

℞ Acid. Carbol. pur. min. 2 ad min. 4
 Aquæ destillat. . . fl. oz. 1
 Misce.

39. Lotio Aluminis.

℞ Aluminis . . . gr. 4
 Aquæ destillat. . . fl. oz. 1
 Misce.

A powerful astringent, not indicated when the cornea is affected.

40. Lotio Atropinæ.

℞ Atropinæ Sulphatis . . gr. 1
 Aquæ Sambuci . . fl. oz. 2
 Aquam destillat. . ad fl. oz. 8
 Misce.

41. Lotio Belladonnæ.

℞ Extracti Belladonnæ . gr. 40
 Aquæ destillat. . fl. oz. 8
 Misce.

42. Lotio Boracis cum Glycerino.

℞ Boracis . . . gr. 120
 Glycerini . . . fl. oz. $\frac{1}{2}$
 Aquæ Sambuci . . fl. oz. 2
 Aquam destillat. . ad fl. oz. 8
 Misce.

Very useful in eczema of the face and eyelids.

43. Lotio Boracis cum Plumbo.

℞ Liquor. Plumbi Subacetatis min. 30
 Boracis . . . gr. 60
 Glycerini . . . fl. dr. 2
 Aquam destillat. . ad fl. oz. 8
 Misce.

Useful in eczema of the face and eyelids.

44. Lotio Boracis cum Sodâ.

℞ Sodæ Bicarb. . . gr. 60
 Boracis . . . gr. 60
 Acid. Hydrocyanici diluti. min. 40
 Aquæ Sambuci . . fl. oz. 2
 Aquam destillat. . ad fl. oz. 8
 Misce.

Useful in eczema of the face and eyelids.

45. Lotio "Hazeline."

℞ "Hazeline" . gr. 15 ad gr. 20
 Aquæ destillat. . fl. oz. 1
 Misce.

A good soothing application.

46. Lotio Hydrarg. Perchloridi.

℞ Hydrarg. Perchloridi . gr. $\frac{1}{8}$
 Aquæ destillat. . fl. oz. 1
 Misce.

A very useful astringent. May often be used with advantage in rather weaker solutions.

47. Lotio Nigra.

℞ Calomelanos . . gr. 30
 Mucilag. Acaciæ . fl. dr. 4
 Liquorem Calcis . ad fl. oz. 8
 Misce.

For external application in syphilitic affections of lids.

48. Lotio Opii.

℞ Extracti Opii liquidi. . fl. dr. 1
 Acid. Hydrocyanici dilut. min. 30
 Aquam destillat. . ad fl. oz. 8
 Misce.

A good soothing application.

49. Lotio Plumbi.

℞ Plumbi Acetatis . . gr. 2
 Acidi Acetici dilut. . min. 2
 Aquæ destillat. . fl. oz. 1
 Misce.

Useful as a mild astringent. Must not be used if the cornea is ulcerated or abraded.

50. Lotio Quiniæ Sulphatis.

℞ Quiniæ Sulphatis . . gr. 4
 Acid. Sulphuric. dilut. min. $\frac{1}{3}$ vel q. s.
 Aquæ destillat. . fl. oz. 1
 Misce.

Useful as a local application in cases of membranous conjunctivitis and in corneal ulcers.

51. Lotio Resorcini.

℞ Resorcini . . gr. 36
 Aquæ destillat. . fl. oz. 8
 Misce.

A useful mild astringent.

52. Lotio Rubra.

℞ Zinci Sulphatis. . . gr. 1
 Sp. Rosmarini
 Tinct. Lavandulæ comp. āā min. 15
 Aquam destillat. . . ad fl. oz. 1
 Misce.

For external application in wounds of lids.

53. Lotio Sodii Bicarbonatis.

℞ Sod. Bicarb. . . gr. 15
 Aquæ destillat. . . fl. oz. 1
 Misce.

Very useful in ciliary blepharitis.

54. Lotio Zinci Chloridi.

℞ Zinci Chlor. . . gr. 1 ad gr. 2
 Aquæ destillat. . . fl. oz. 1
 Misce.

A more powerful astringent than the following.

55. Lotio Zinci Sulphatis.

℞ Zinci Sulphatis. . . gr. 1 ad gr. 2
 Aquæ destillat. . . fl. oz. 1
 Misce.

56. Unguentum Acidi Borici.

℞ Acid. Borici . . . gr. 60
 Vaseline Alb. . . oz. 1
 Misce.

57. Unguentum Atropinæ.

℞ Atropinæ (alkaloid) . . gr. 4
 Vaseline Alb. . . oz. 1
 Misce.

58. Unguentum Atropinæ cum Cocainâ.

℞ Atropinæ (alkaloid) . . gr. 4
 Cocainæ . . . gr. 8
 Vaseline Alb. . . oz. 1
 Misce.

Sometimes produces greater effect in iritis than the preceding formula.

59. Unguentum Belladonnæ.

℞ Extracti Bellad. . . gr. 120
 Lanolin. . . gr. 180
 Ol. Amyg. dulce . . q. s.
 Misce.

Make to consistency of butter.

Useful ointment in iritis. To be rubbed over brow.

60. Unguentum Cocainæ.

℞ Cocainæ (alkaloid) Hydro-
 chlor. . . gr. 8
 Vaseline Alb. . . oz. 1
 Misce.

61. Unguentum Eserinæ.

℞ Eserinæ (alkaloid) . . gr. 1 ad gr. 2
 Vaseline Alb. . . oz. 1
 Misce.

62. Unguentum Hydrargyri Ammoniat.

℞ Hydrarg. Ammon. . . gr. 8
 Vaseline Alb. . . oz. 1
 Misce.

Very useful in impetiginous sores of lids.

63. Unguentum Hydrargyri cum Belladonnâ.

℞ Extract. Bellad. . . gr. 60
 Unguent. Hydrarg. . . oz. 1
 Misce.

To be rubbed into the temple and around brow.

64. Unguentum Hydrargyri Iodidi Rubri.

℞ Hydrarg. Iodidi Rubri
 gr. 10 ad gr. 15
 Vaseline Alb. . . oz. 1
 Misce.

A mercurial counter-irritant.

To be rubbed into the temple at night. In applying this ointment the fingers should be covered with a glove.

65. Unguentum Hydrargyri Nitratis diluti.

℞ Unguent. Hydrarg. Nitratis gr. 60
 Vaseline Alb. . . oz. 1
 Misce.

Useful in ciliary blepharitis.

66. Unguentum Hydrargyri Oxidi Flavi.

℞ Hydrarg. Oxid. Flav. gr. 2 ad gr. 8
 Vaseline Alb. . . oz. 1
 Misce.

**67. Unguentum Hydrargyri
Oxidi Flavi cum Atropinâ.**

R̄ Hydrarg. Oxid. Flav.	gr. 4
Atropinæ (alkaloid)	gr. 2
Vaselin Alb.	oz. 1
Misce.	

68. Unguentum Iodoformi.

R̄ Iodoform. Præcipitat.	gr. 15 ad gr. 30
Vaselin Alb.	oz. 1
Misce.	
Useful in sloughing ulcers of the cornea.	

**69. Unguentum Iodoformi cum
Atropinâ.**

R̄ Iodoform. Præcipitat.	gr. 20
Atropinæ (alkaloid)	gr. 2
Vaselin Alb.	oz. 1
Misce.	

70. Adrenalin.

Prepared 1 in 1000 of normal saline solution, with $\frac{1}{2}$ per cent. of chloretone as an anæsthetic preservative (Martindale). It acts as a powerful hæmostatic, and is useful in controlling hæmorrhage in extra-ocular operations, such as tenotomies and advancements.

TABLE OF APPROXIMATE EQUIVALENTS.

SOLID.	FLUID.
15 grains = 1 gramme.	17 minims = 1 cubic centimètre.
60 grains = 4 grammes.	60 minims or 1 drachm = 3·5 cubic centimètres.
1 ounce (437·5 grains) = 30 grammes.	8 drachms or 1 ounce = 30 cubic centimètres.
1 pound = 453·5 grammes.	20 ounces or 1 pint = 568 cubic centimètres.

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